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GT350

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DYNO, AND
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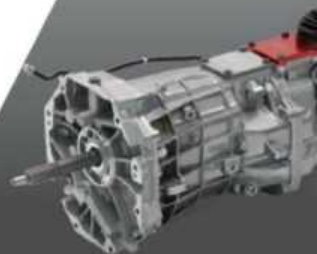
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16



22



24



34



56



70

ON THE COVER:

It's been 50 years since HOT ROD featured a Ford Y-Block on the cover, but when Jon Kaase Racing Engines built this one to go up against the School of Automotive Machinists' Poly 318 (shown above) for the 2015 AMSOIL Engine Master Challenge, we knew it was time to rectify that oversight. Jonathan Klein (@jk69erboy on Instagram) summed up our feelings exactly when he wrote on our Instagram page, "So much for buying blocks for \$100 anymore." Photo by Brandon Gillogly.



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Evolving an Icon



It's risky to mess with hot rod nostalgia. Our memories of past loves are always more polished and powerful than the reality that really was. And when the nostalgia you're trying to recreate is shared by a group as passionate as ponycar lovers, those challenges become more daunting.

So when *Motor Trend* announced the new Camaro SS was its Car of The Year for 2016—a rare moment when HOT ROD agrees with our younger brother—I've got to hand it to Chevy. Reimagining a car as popular as the first-gen Camaro into a modern success isn't easy, especially when the only spec Chevy could carry over was the customers' passion.

How did Chevy do it? It brought together a team of first-gen Camaro owners and lovers. Chief amongst them Al Oppenheiser, the Camaro's head engineer—a guy with a 1968 Camaro convertible in his garage. Passionate cars are his comfort zone.

[The 2016 Camaro's chief engineer, Al Oppenheiser, has done the automotive equivalent of getting Led Zeppelin back together—and making them sound better than ever before.

The night Oppenheiser's team won *Motor Trend's* award, I asked him what it was about Camaro that was cool in 1969 and is still cool today. The answer was easy for him. "The DNA comes from the car's beautifully styled long dash-to-axle and strong rear shoulder," he said. That, and the car was "meant to be something you could get in after a hard day of

work and go out and tear up the track or country roads."

Oppenheiser acknowledges that's not a relationship that just Chevy owners look for: "I know our friends over in Dearborn have the same thing with Mustang. It's this thing that people name [their cars], and make them part of their family."

When I asked him if it was harder to engineer the fifth-gen or sixth-gen Camaro, he said it was tougher to bring the car back. "When we brought out the fifth-gen car at the North American Auto Show in 2006, we had no idea; we didn't clinic it because everyone would've known what it was." That was the day that Chevy literally held a car cruise inside Detroit's Cobo Hall with Bob Lutz and even Roger Penske on hand to add to the energy.

"So we went on the expertise of people like Ed Welburn and Mark Reuss, and everybody that had an involvement in the fifth-generation concept car. What we learned in the fifth-gen was that Chevy people will buy the Camaro and Ford people will buy the Mustang—it's those other people that you've got to capture, and how you do that is with upping your game with technology," hence the 2016.

I think Oppenheiser's right on the money about that, whether you're doing an automobile, a movie, or a magazine.

➤HOTROD.COM/David-Kennedy



William Walker

IN MY OPINION

Great Quote
"The work of the individual still remains the spark that moves mankind forward."
— Igor Sikorsky

Transmission Choices
I've had a 4L80E automatic transmission on my desk for the last two weeks. It's been sitting here while I figure out a shift-linkage for my latest project. I stare at it between stories and find myself wondering if I'll ever buy another manual. Now that automatics are the performance option, buying a six-speed car means you got the slow one. The problem is, autos are no fun to drive. Somebody needs to fix that.

Drag Weekend (West)
You'll read about HOT ROD's first Drag Weekend in this issue, and you'll want to join us for the next one: April 1–3, 2016, in Arizona. Go to HOTROD.com/Events to register. Drag Week 2016 will follow its usual format in September, and then we'll add a second Drag Weekend (East) event in the fall. Stay tuned.

Farewell
To Assistant Art Director Carlo Anacta, who's moving on to another job. HOT ROD thanks you for the hard work!

➤HOTROD.COM/Brandon-Gillogly



We recently got back from the Performance Racing Industry Show in Indianapolis. On display was just about every machine you'd need to build a car from scratch, including the engine block. There was also one of every kind of race car you could think of. It's pretty much three days of milling around the best garage ever.

➤HOTROD.COM/Elana-Scherr



We've entered a rare rainy season in California. Guess how many of my cars have both working defrosters and windshield wipers. Hint: The correct number is not any.

➤HOTROD.COM/Thom-Taylor



I love Ford Motor Company, but I don't know how I feel about them going to the Dark Side and hooking up with Google's anti-car autonomous car program. Electric cars are bad, but this might be going too far for a company striving to make driving fun.

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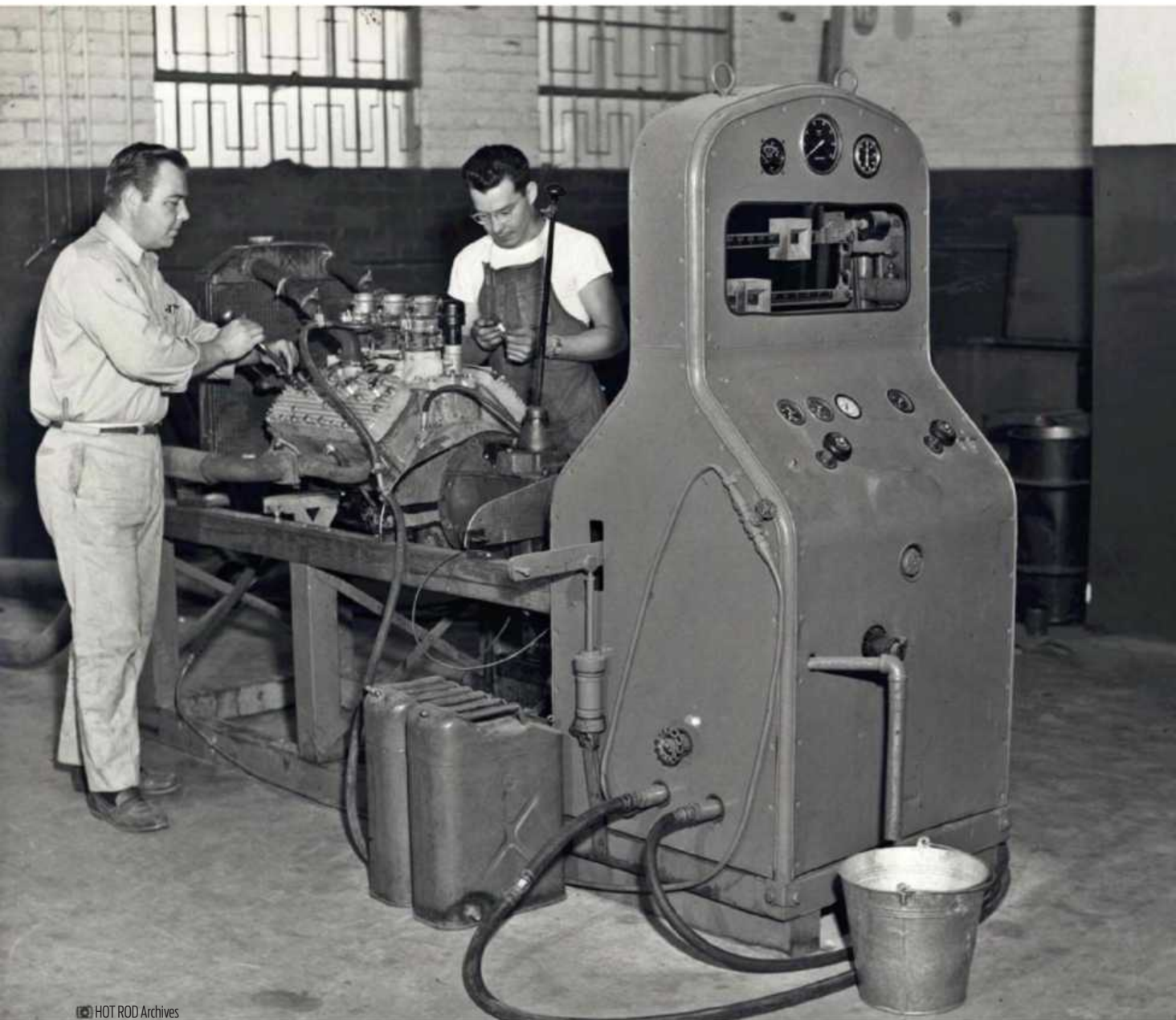
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Spreading the Dyno Religion



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Today it's hard to imagine not having access to a dynamometer to determine true horsepower and whether your engine will hold up before jaunting 1,000 miles to Bonneville, only to blow it up on the first pass. When HOT ROD started in 1948, dynos were very exotic. It only took four issues (April 1948) before HOT ROD was filling readers

in and singing the praises of dyno testing.

In an article by Kenneth Harmon, better known as Kenny Harmon of Harmon and Collins fame, he spread the word on the merits of dyno testing. That included sage advice like, "Attempting to develop or tune an engine without a dynamometer is time consuming and not too conclusive," and, "Three

days on the dynamometer is worth three years at the Lakes."

Harmon was speaking from experience, as he had a dyno at his shop to test his own cams and also race engines like the lakes engine he initially dynod at 147 hp for the article. By week's end, Harmon had wrung almost another 50 hp out of it. As he stated, "Will some builders pooh-pooh the

dynamometer? We think so. But they had better stand back out of the draft!"

Though shots of Harmon's dyno don't exist, we do have this great shot of Edelbrock's first dyno, its 200hp Clayton unit in 1949, with Edelbrock technicians Bobby Meeks (left) and Fran Hernandez (right) testing a "full house" Ford flathead.

➤ HOTROD.COM/Thom-Taylor



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Imagine a 200-mph helicopter that can hold as many passengers as a school bus, is heavier than a fully loaded semitruck, and goes fishing for sea mines with a turbine-powered catamaran as the bait. That's what you're looking at right here. It's a triple-turbine, 22,500hp, heavy-lift helicopter built by the Sikorsky Aircraft Corporation (now part of Lockheed Martin) in Connecticut. It's called the CH-53K King Stallion and is currently in development to replace the existing CH-53E

Super Stallion for the United States Marine Corp, with an estimated arrival date of 2018–2019.

It takes a crew of five to operate an aircraft like the CH-53K. Two pilots control the fly-by-wire operating system inside the new digital-glass cockpit, which sends and receives electric signals to control all of the craft's flight systems. The helicopter's main gearbox features a revolutionary split-torque design that distributes power from each of the three 7,500hp

General Electric T408-GE-400 turbines through a series of helical gears and shafts on its way to the 80-foot-diameter main rotor and 20-foot-diameter tail rotor. The CH-53K is said to be capable of lifting a maximum external load of more than 50,000 pounds.

The interior cabin space of the CH-53K aircraft is also impressive for a helicopter. The cargo area is 30 feet long, 9 feet wide, and has a 6½-foot ceiling height, leaving plenty of room for the 37 troops (or up to 55

when installing the centerline seats). Even a Humvee can be secured as interior cargo if they don't want to hang it from one of three tow hooks on the bottom of the aircraft. Yes, the CH-53K can slingload carry multiple vehicles from the bottom of the airframe.

Whether its carrying troops or equipment to its destination, the CH-53K will get the job done as the largest and heaviest helicopter entering the United States military fleet.

▶ **Cody Kanuscak**

DO YOU HOT ROD EVERYTHING?

If you've hopped up anything that's not a car, let's see it! Hot leaf blower? Bitchin' gas grill? Customized kitchen cabinets? Anything goes. Email pics and details: HOTROD@HotRod.com.

▶ There are three General Electric T408-GE-400 turbine engines unleashing 7,500 shaft horsepower.

The tail rotor measures 20 feet in diameter and is canted 20 degrees from the centerline to improve lift characteristics of the craft.

FISHING FOR SEA MINES?

It sounds insane, but one of tasks the Sikorsky MH-53 Sea Dragon (similar to the CH-53K) helicopters was designed for is to find and detonate explosive sea mines to protect aircraft carriers and open strategic waterways around the globe. To do so, these helicopters drag a 9,750-pound MK-105 magnetic influence minesweeping boat up to 28 mph from a 450-foot cable attached to the aircraft.



It is a rare opportunity to be part of a team that defies the laws of gravity and puts the aircraft in the air.”

— Andy Bernhard, Chief Engineer, CH-53K Program

Readers' Projects

Want to share your car with the whole world? Send photos and info to HOTROD@HotRod.com.



Jimmy Turk // Tulsa, Oklahoma

Jimmy's 1923 Ford Model T C-Cab Delivery is driven by a 383ci Chevy small-block and has personalized touches like a 1934 grille and Cadillac Deville taillights.



Vance Reynolds // Snyder, Texas

This 450hp 1967 Firebird is powered by a Pontiac 455 connected to a five-speed Tremec and a 3.55 posi rear end.

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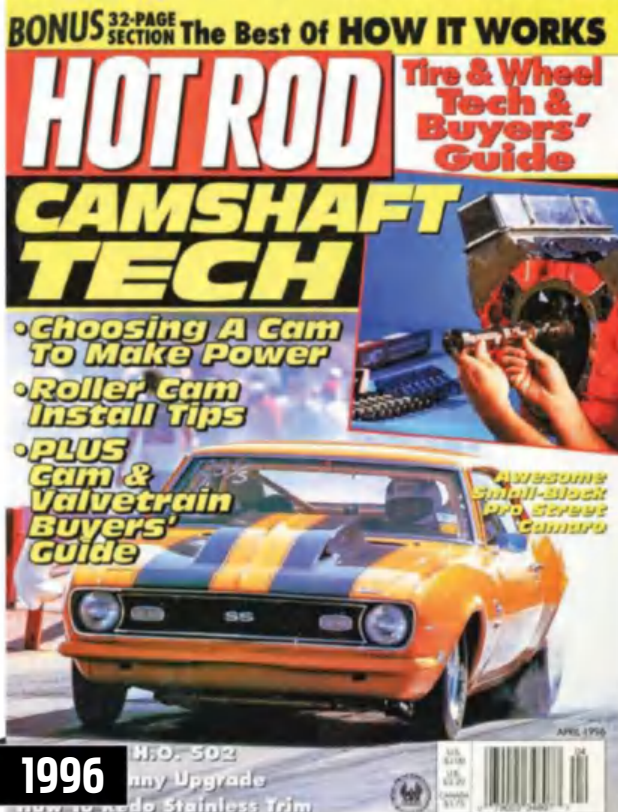
The HOT ROD Archives



1976



1956



1996

20 YEARS AGO

April 1996 (148 pages, \$3): Anyone considering a cam swap must've loved this valvetrain-heavy compilation by a star-studded staff boasting no fewer than three past and future HRM editors (John Dianna, Jeff Smith, and Rob Kinnan). Then-leader Drew Hardin's editorial about whether Plymouth's upcoming Prowler would be accepted as "a true hot rod" referenced a contemporary USA Today article in which Boyd Coddington voted no. Buried treasure on the opposite end of this package (page 99) was Jim Brown's photography of famous rods, customs, and race cars at the two-year-old Petersen Automotive Museum, expertly captioned by Gray Baskerville.

40 YEARS AGO

April 1976 (138 pages, \$1): John Dianna's column dashed longtime readers' hopes that a recent change in editors might finally end HRM's infatuation with "those damn vans" (and the long-haired weirdos who drove them). Instead, Johnny promised expanded coverage and a monthly van section. Our centerspread was a cartoonish board game, drawn by CARToons staff artist Dennis Ellefson, whose "object is to get to the Truck-In as quickly and efficiently as possible." (No, it was not an April Fool's joke.) Real-life speed tips were packed into a 14-page *Pressure Cooker* section by Tech Editor C.J. Baker, an early proponent of turbocharging in the bad old days of carburetion.

60 YEARS AGO

April 1956 (76 pages, 25¢): The eight-page "signature" added to this month's package size became the new normal for a title attracting unprecedented attention from advertisers and readers. Don Francisco's cover story demonstrated HRM's continued support of the little engine that fueled the fast expansion of hot rodding and an after-market industry. However, it was another how-to article that signaled the switch underway to overhead V8s, in general, and to Chryslers in particular: "Firepower for Fords" followed Art and Lloyd Chrisman's installation of a free 1956 Hemi (awarded for setting top speed at the inaugural NHRA Nationals) into their 1952 Ford pickup. Art still has them both! > **Dave Wallace**



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He's going to remember your face, one way or another.

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Take 5 With JEFF DUNHAM

Jeff Dunham is a car guy for dummies. That's not an insult! He's a ventriloquist, speaking through handmade puppets that allow him to play both straight man and punch line at the same time. Dunham is one of the top five most well-paid comedians in the world, raking in millions with an act that's taken him around the world. His success has also allowed him to amass quite a car collection, which, like his show, is full of cartoonish characters. Sure, there's a pair of Ford GTs, a McLaren, and a Viper or two, but they share garage space with a Levi's edition Gremlin, a Pinto Cruising Wagon, and a fleet of tiny VW-powered kit cars of various makes and models. Dunham has muscle cars—he famously traded in a Prius for a Hellcat Challenger to match a 1970 E-body—but he also has two Batmobiles, a shag-carpet-covered van, and a lake-ready Amphicar. Dunham's garage is like a kid's basket of Hot Wheels made life-size, and as we discovered, that's exactly how it all started.

► HOTROD.COM/Elana-Scherr

HRM How many cars do you have right now?

JD 72.

HRM You didn't even have to count on your fingers or anything!

JD That's because my accountant told me that this morning.

HRM What came first, the interest in comedy or cars?

JD Cars didn't happen until years later. My father was not mechanically inclined *at all*. His idea of a car was to purchase a vehicle at the cheapest

price possible, drive it from point A to point B for the longest amount of time possible until the floor rotted out, and that was what I thought a car was for. But as a kid, I was very much drawn to Hot Wheels. I distinctly remember being in Kmart and getting a little purple "Silhouette." I still have it. In 1993, when I was driving down the freeway in San Diego and looking over at the Dodge dealership, I saw this red Viper sitting in the window and it was basically the first fullsize Hot Wheels I'd ever seen. I was hooked from then on.

HRM So when does a guy decide, "I want to have more than the average amount of cars?"

JD It's some kind of sickness. But every car that I buy, it has to at least have a shot of maintaining its value or increasing in value. Basically, cars are my stock market.

HRM So the Pacers and Gremlins are an investment?

JD They can't ever be worth less! But, hey, I've got the Ford GTs; hopefully, that will make up for any of my mistakes.

HRM You have a lot of sort of comical cars in your collection: Baris customs, Meyers Manxes, the Amphicar, Bradley kit cars. Do you see any connection between what you do for work and what cars you choose to collect?

JD Yeah, I think so. Having made people laugh for however many years, there's that entertainer thing. You want people to have fun, and I love when people see these things and they're delighted. They're just loaded with character. You have all these artists and engineers and so many people that put the best of themselves into their cars.



Elana Scherr



HRM If you were going to make a puppet out of any of your cars, which one?

JD The '40 Ford truck. He'd be like my character Bubba J, just kinda stupid. Or the '79 Trans Am that thinks it's badass, but doesn't realize all the emissions stuff got stuck on it, so it really isn't as good as it thinks it is. He'd be all talk, no action.

HRM You've mentioned that one of the things that got you into comedy was being a bit of a shy kid. Do you feel like cars can be an icebreaker like jokes are?

JD I love going to the car shows and looking at what everybody has. I hate going to parties, 'cause I'll stand in the corner. I'm not a social butterfly. At the car show—I like going to Supercar Sunday in Woodland Hills [California]—I'll talk to some of the same people every week, but also new people. I think it draws every walk of life. I'll tell you, one of the most meaningful car events I ever went to was when Warner Bros. got all five Batmobiles out [in 2012] and went to Bob's Big Boy on a Friday night. Every income bracket was represented and everybody was enjoying the same thing at the same time and it didn't matter who you were, what color you were, how much money you had—we were all equally happy. And that's what car shows are like.

HRM Are car collectors competitive?

JD I don't know! You can't compete with [Jay] Leno. Nobody can compete with Leno. I don't hang out with other car collectors. Here's why I don't think I'm competitive with anybody. I think everyone has their own thing. Like, I

wouldn't get in an argument with Jerry Seinfeld; he loves Porsches, I don't care. That's his thing. There's nothing to get jealous of. Yay, Jerry, you love Porsches! Good for you!

HRM Does being famous make being a car guy easier or harder?

JD I think it makes it easier—no, wait. Maybe it does make it harder, because people think you know what you're talking about. That's Jay's fault. I'm still learning, but I got started very late in the game. I wish I'd taken auto shop.

HRM There's video online of you fabricating the skull for your Achmedmobile hot rod. Where did your fabrication skills come from?

JD That just came from necessity. I built my own dummies. I was looking for characters that would be unique to me. I just got tips from a few people and just started teaching myself. I'd been flying radio-controlled helicopters for a number of years, so the mechanics of how a helicopter works, a lot of those mechanisms are in the dummies now. The working knowledge of engines also came from the helicopters. That's how I was able to build the dummies and that's how I was able to build big helicopters as well. I'd love to build a kit car; I don't know which one I'd go after. Meyers Manx has that really cool Dual Sport, with the Subaru engine.

HRM Do you use any of that fabrication knowledge on your own cars?

JD Oh, limited stuff, but when I got a guy here that's been working on cars for 50 years, what, am I really gonna try and rebuild that carburetor? No, he can do it.

HRM Do you have any automotive heroes? You have a bunch of Barris cars, did you spend time with him?

JD George was great. I called him the P.T. Barnum of the car business, because he was a promoter and a seller. He surrounded himself with a lot of skilled people and a lot of imagination. Another hero would be Andy Smith, the guy who designed and built the Batman Tumbler.

HRM How many Barris cars do you have?

JD Five. Hard Hat Hauler, Voxmobile, Calico Surfer, Batsmart, T Buggy. And the 1966 replica Batmobile.

HRM What do you do with your cars?

JD I've gone to a couple of tracks, had a blast at Spring Mountain with my 2014 Viper. Am I gonna win any competitions? No. Do I have fun racing them? Absolutely. Am I any good? I dunno.

HRM How big are you going to let your collection get?

JD I don't know. I think once you get past 100, you're being stupid. Cars are supposed to be driven. You're supposed to drive the car. The car was made to be driven. They're sad if they're not. If you get a leak, fine. If it's not bleeding, it's not alive.

HRM Do you think liking cars is politically incorrect?

JD If it is, I don't care, but if you do stuff like this and you have a hobby this big, you sure as heck better be giving to charity, giving back, 'cause you can't have stuff like this and not share. That's pretty important to me.



I love cars they didn't make 10 million of.”
— Jeff Dunham

CARS WITH CHARACTER

You're probably familiar with George Barris' involvement with the Batmobile, or John DeLorean's eponymously named time traveler, and maybe even Bruce Meyer's bobtailed buggies—all of which can be found in Dunham's garage. The funnyman has a penchant for vehicles with a story, but not many people know the history of "Mad Man" Earl Muntz, creator of the Muntz Jet.

Muntz was an inventor and promoter in Los Angeles. From the 1940s until his death in 1987, Muntz made and lost several fortunes in everything from television sets to home and car stereo systems, and along the way, a sports car called the Muntz Jet. In 1950, Muntz bought the assets of the Kurtis company and used Cadillac, and later, Lincoln V8s to scoot the sportster down the road. The cars were fast and often customized by Muntz in wild upholstery or with such options as a telephone or an insulated beer cooler. Somewhere between 200 and 400 Muntz Jets were made in its four-year run. Muntz lost money on every car, but they are highly collectible today.



HOT ROD TRENDS FOR 2016

➤ Every year HOT ROD treks to see the sea of sights at the SEMA Show, but once we see certain components, tricks or colors repeating, we bring it to you for your chance to agree or disagree on the staffs' observations from the show. Some of these trends have been around for a while, but have been marinating while designers and builders embrace them—or dump them in the grease.

Overall, we'd say there seems to be a release from the constraints of the past. Builders are trying different combos and colors that we wouldn't have seen even two or three years ago. There is less inhibition and more flamboyance and creativity popping up—which can be good or bad, depending on how well it's executed and whether it's actually cool or just a bad attempt at perceived coolness.

As a general trend, we would also say that the accepted approach to SEMA builds is if one is good, two are better; if big is good, bigger works better; and less is least at SEMA. Sometimes complicated solutions do

not necessarily make sense, but they attract lots of attention for their complexity and fabrication challenge. So the fabrication is, in some cases, taking precedence over function, just as in some cases elaborate paint jobs become an exercise in paint mastery, and not necessarily as a design element that integrates well with the car or truck.

One trend we found hard to show but which made its appearance on numerous professionally built cars was the belly pan. Yes, that race-car appendage from before WWII that not only hides ugly undercarriages and looks cool but also turns your ride into a moving microwave oven, could be found on early and late builds incorporating tunnels, louvers, or just as a cool add-on. This becomes yet one more item to add to a builders' bag of tricks, and isn't the sort of thing just anybody can go out and buy at Pep Boys, which raises its status on the builder cool-factor list.

So check out our 20 trend, or non-trends, seen at SEMA and see if you agree. Or not.

**20 Trends We Saw
at the 2015 SEMA
Show—and Some
We Thought We'd
See** Thom Taylor

COPPER IS THE NEW CHROME

Above: We are seeing copper-plated wheels, components, and tubing used on many builds—especially on black vehicles. In many cases, it's the steam-punk trend oozing over into car building, or maybe the builder likes the look and uniqueness of copper. Maybe they like how it contrasts with black and dark colors. Who knows? The point is it's being used in different ways on many cars as we walked the show.



NO, WAIT, NICKEL IS THE NEW CHROME

It would appear that nickel plating and/or brushed trim and bumpers has taken over, leaving chrome as useless as yesterday's newspaper. Most of the big-dog builders brought cars to SEMA that featured toned-down trim and bumpers in some form or another.



OVERLAPPING BODYWORK

Especially with the imported cars, this is huge, and reflects the aero management seen on road racing and Formula 1 race cars migrating to street cars. The oft-times fragile, simplistic splitters and diverters look a bit Ricky Racer to us, but they're extremely popular and quite the trend at the moment.



ETCHED SHEETMETAL

We've seen this on bikes for years, on engine components, and done sparingly on low riders. But it was spotted on numerous cars, indicating that builders like the elaborate, fussy detail of etching on a larger expanse of metal, or find it as a new way to individualize. Much like engine-turned gold leaf, it pulls you in to give your eyes a second look. We can't say we'll be seeing this pop up on Drag Week cars, but as a focal point it does have a certain double-take quality about it.



BANDED

What we are calling "banded" details are going beyond the aftermarket off-road truck grilles we have seen for years—it's now taking over whole sections of cars and trucks. It may be an excuse to also add round-head bolts or chrome-y studs for added bling. Whatever, we are seeing more and more of it enveloping the whole car like a metal form of kudzu.

LED LIGHTS EVERYWHERE

It had to happen. With LED technology being cheap and easy, it was only a matter of time before it would be introduced to every crevice and fold of the car, and now it has proliferated to wheels. We saw quite a number of lights as dress-up items integrated into wheels. Since wheels are the only part of the car you actually see move, it makes sense as an easy attention-getter.





SECTIONED LOWNESS

There were at least three of these sectioned, channeled Camaros at the show, which is kind of weird because the process of sectioning a car is not exactly easy. Because of the extreme tuck to the side section of a first- and second-gen Camaro, maybe all these builders are doing is trimming off a few inches from the bottom and raising the wheel openings up into the body a bit—we aren't sure. But we do know that seeing three of these was not expected.



CHOPPED-OFF FLARES

These were everywhere, and emulate road racers' habit of chopping off flares above the rockers—which we're not quite sure why unless they're trying to eliminate weight while still covering tire tread per rules? Not sure, but it looks weird on street cars because we've been so used to flares tapering off as they wrap around a wheel opening, so this doesn't make a lot of sense.



CHROME AND POLISHED ALUMINUM ARE DEAD

All of the pro-built cars seem to have done away with chrome and polished aluminum as finishes or accents in engine compartments. It almost seems taboo, and honestly gives the person looking under the hood a chance to actually take in the glory of an engine compartment without having to wear sunglasses and sunblock.



3-D PARTS PRINTING

It's everywhere—but are we seeing better, more integrated design? In some cases, no, and it costs the same to do a well-designed part as it does an ugly one.

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GASHED HOLES IN SHEETMETAL

Ripped, gouged and gored sheetmetal goes right along with patina as the new way to add a distinctive element to your vehicle. Whether preserving an as-found part or adding a vent in a dramatic fashion, we saw quite a few examples.



ELABORATE BEYOND BELIEF

As a way to engage admirers of your building prowess, and as a means to stand out in the massive SEMA crowd, you need to over-think and over-engineer your brackets, supports, and suspensions to confuse and delight the masses. At least that's what it looked like to us.



ELABORATE AND BIG TURBO PLUMBING

Coming up with ever more imaginative, flamboyant, and elaborate ways to route your exhaust gases on your gas or turbodiesel setup, is the preferred path to success. We saw many examples of the in-your-face approach to compound and twin-turbo engines.



MYSTERY VENTS

Vents and body openings are everywhere—placed all over cars. Even vents inside of vents were seen. This 1965–1966 Mustang Fastback continued its distinctive cove forward into the front wheel opening, where it became a vent.

ODD COMBO OF DEEP WHEELS AND THROUGH-BODY EXHAUST

What started as a curious combination became a downright trend once we kept noticing that whenever a super-deep-dish wheel was used, an exhaust tip running through the quarter-panel accompanied it. It's as if you can't do one without the other.

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CHEAP SCREEN AS GRILLES

Seen on three or four vehicles, the once high-grade woven material used for grilles has given way to cheap-to-buy, and cheap-looking grille material. Maybe the owner or builder ran out of time when they got to this part of the build? We're not sure, but it's a trend.



STILL MORE ANODIZED WHEELS

This was a trend last year we wrote about, and it wasn't watered down at all this year. Again we saw many, many examples of anodized aluminum wheels on myriad cars and trucks.



PAINT OR WRAP?

Wraps are getting so good that it's getting harder to tell if you're looking at actual paint or a vinyl wrap. Obviously when you get up closer you can tell, but walking through the aisles of SEMA you were easily fooled by the well-done execution of some of the vinyl wraps.



WHEN DID RUST BECOME SHINY?

At SEMA it was. Rust and patina buried in clear for different reasons was in abundance. Unfortunately, it looks odd at best. Our suggestion would be to either keep your patina patina-ing, or paint it and be done with it.



DULL PAINT FADING—BECOMING ACCENTS INSTEAD

We are finally starting to see the end of flat or semigloss paint. It's still around, but seems to be slowly fading to instead become a same-color accent. Works for us.

WHAT WE THOUGHT WE'D SEE—BUT DIDN'T

Methanol Engine Builds. Methanol is cheap, 80 percent the efficiency of gasoline, and burns clean in this ever changing world of global warming. Since it's used for racing, without these advantages considered (except maybe the cheap part), we have been expecting a crossover into street applications inspired by Drag Week's Unlimited class.

Compound-Turbo Gasoline or Methanol Engines. Compound turbos (two turbos paired in series) are the big rage on diesels. They spool up quicker because both turbos share the work. We have been expecting this next phase in turbo installs and expect to see this type of setup become much more popular in the coming years on small engines with high-octane fuel.

Carbon-Fiber Wheels. Wheel companies have been working on these for years, and companies like Carbon Revolution, iForged, and some car companies—including Ford, with its optional wheels for the new GT350R Mustang and 2017 Ford GT—seemed to lay the groundwork for a gang of SEMA builds featuring carbon-fiber wheels. Maybe next year?

Multiple-Engine Vehicles. Though there were a couple of multiple-engine race cars hiding around SEMA, we are seeing the limits of horsepower output from single-engine applications, and in true hot rod spirit, when you've reached the limits of one of something, try two. It's an old approach, but not lately with so much lighter-weight components and so much more horsepower able to be wrung out of engines. How would a twin-engine Hellcat with a combined 1,414 hp do on the street and strip? ☐

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✓ Steve Dulcich, Brandon Gillogly, and Thom Taylor

📷 Brandon Gillogly and Robert McGaffin

► HOT ROD's AMSOIL Engine Masters Challenge was quite different this time around. It was still at the University of Northwestern Ohio and still had some familiar faces and teams, but for 2015 there were five classes, more than 20 engines, and a shootout each day to determine a winner.

In the past, there was only one winner after four days of qualifying and one day for final eliminations. The scoring was handled by taking an average of the power made on three runs in a 30-minute window each engine spent on the dyno. The top five engines were taken into Friday's eliminations, where the most power and torque over a determined rpm range (divided by engine displacement) won the entire event.

This was the first year for the new HOT ROD format featuring a shootout each day with a wider variety of classes, and each class winner took home \$12,000, the runner-up got \$3,000, and both received a drum of VP racing fuel to keep their high-horsepower habit fed for a while longer. The five classes for 2015 were: Vintage, Spec. Small-Block, LS Bolt-On Shootout, Hemi Generational Challenge, and Big-Block. Each competitor could make as many dyno pulls as needed in a 35-minute timeframe to make a minimum of three runs, and the best torque and horsepower average over those three runs, divided by displacement, won that class.

The new format brought an even wider range of engines than we were used to seeing at the AMSOIL Engine Masters, and the Vintage class brought some surprises, with old engine architecture getting a massive dose of new technology. We're bringing you the first three classes now, and we'll have the standouts from the Hemi and Big-Block classes throughout the year in HOT ROD tech articles.





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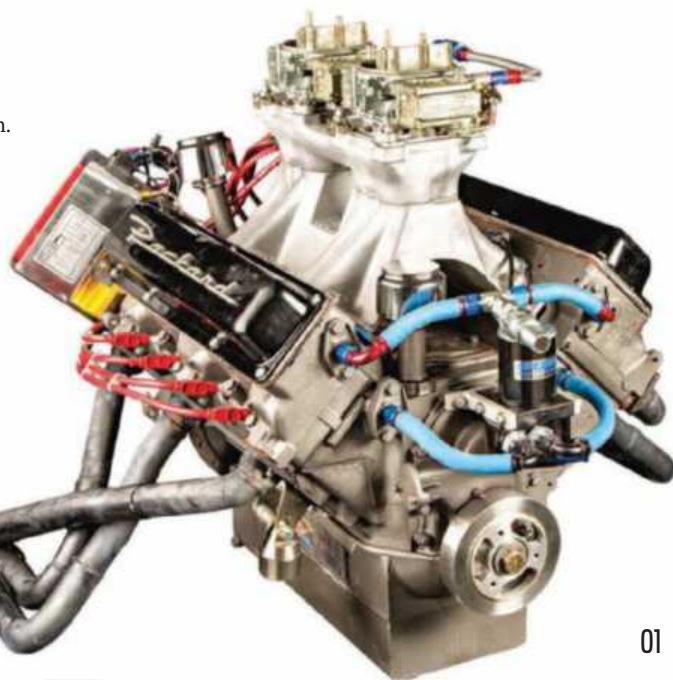
This year's introduction of a Vintage Engine Class (pre-1955 American V8 engines) to the 2015 AMSOIL Engine Masters Challenge was sure to bring out some unusual iron, but we never expected to see an all-iron Packard enter the ring. Lynn Peterson and the Kustom Kemps team figured the 363ci Packard V8 was an ideal choice for the Vintage class, not an unreasonable opinion based on Peterson's decades of experience with the make. The engine was pulled from a Bonneville land-speed race car and freshened up for the AMSOIL Engine Masters Challenge.

The tale of the tape certainly shows this engine's heavyweight credentials, with a monstrous 5.00-inch bore spacing, 750 pounds of high-nickel-content iron cast in Warren, Ohio, and an internal structure resembling the Brooklyn Bridge. So it's heavy duty, and with Packard's conservative engineering, built to last.

But what about performance? Believe it or not, those antiquated cylinder heads were capable of flowing 270 cfm dead stock, and with porting on this engine, crested the 300-cfm mark through the stock 2.00-inch valves. Even the shared center exhaust port, reminiscent

of an Olds Rocket V8, didn't seem to hamper performance too much. Internally, this engine relies on the stock cast-steel crank and rods, parts that Lynn considered more than adequate for 6,000 rpm.

A reground Isky roller cam with tightened lobe-separation angles and a bit more lift combined with a Mopar 440 tunnel ram that was a close match to the Packard heads greatly increase induction flow. Peterson says the Weiand part needed only a small amount of machining and then a small adapter, with the middle intake ports moved 0.20-inch inward to mate up to the Packard heads. Custom pistons pushed the compression ratio to 13:1, with the combustible mix provided by a pair of 450-cfm Holley carbs. The adjustable rockers came from an unlikely source: Ford's big 477/534ci family of industrial gasoline truck engines. Peterson's Packard kicked off the vintage engine competition, running cleanly and easily to the required 6,000-rpm redline. The 363ci engine completed the competition session making as much as 449 hp in the process. Packard Power—it may be something to consider.



01

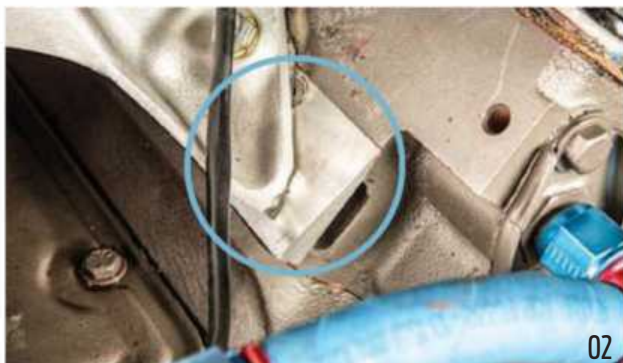


| | |
|--|-------------------------------|
| ENGINE BUILDER | Lynn Peterson |
| ENGINE TYPE | Packard V8 |
| CLAIMED DISPLACEMENT | 363 ci |
| BLOCK | Factory cast iron |
| COMPRESSION RATIO | 13.0:1 |
| CRANKSHAFT | Packard |
| CONNECTING RODS | Packard |
| PISTONS | Aries |
| RINGS | Aries |
| CAMSHAFT | Isky 234/240 duration |
| CYLINDER HEADS | Factory Packard iron |
| INTAKE MANIFOLD | RB Chrysler Weiand tunnel ram |
| CARBURETOR OR EFI SYSTEM | Dual Holley 450 |
| HEADERS | Get Bent exhaust |
| AMSOIL OIL | 10W-30 |
| AVERAGE PEAK HORSEPOWER OVER THREE PULLS | 447 hp |
| AVERAGE PEAK TORQUE OVER THREE PULLS | 441 lb-ft |

01] When the Vintage class was created, we had no idea a Packard would show up. Which is exactly why we created a Vintage class.

02] Wedge-shaped adapters were needed to mate the Weiand tunnel ram, intended for a Mopar RB V8, onto the Packard heads.

03] With only three exhaust primaries, the big Packard mill looked like it would be seriously hamstrung. Its solid performance proved otherwise.



02



03

402ci

CHRYSLER POLY

"The head and valve layout was something that we could make work, and we did end up with 340 cfm by the time we were done. The problem with

When you think of a Chrysler 318, you may think of one of the millions of gentle small-block Chryslers built from the late-1960s well into the 21st century. Looking back into the geology, these familiar powerplants, known as the LA-Series, trace their lineage to the earlier Chrysler A-Series Polyspherical-head small-block that debuted in 1955. The shared gene pool is clearly demonstrated by the many internal components that interchange between these engines. Where the engines are distinctly different is in the head layout. The LA engine features ordinary inline valves in a wedge chamber. In contrast, the Poly engine used an opposed-valve layout, not unlike the Gen III Hemi, with the valvetrain operated by a single-shaft rocker system.

It takes a trained eye to recognize the potential of the neglected Mopar Poly, and Judson Massingill of the School of Automotive Machinists (SAM) was just the man to envision the possibilities. Massingill tells us,

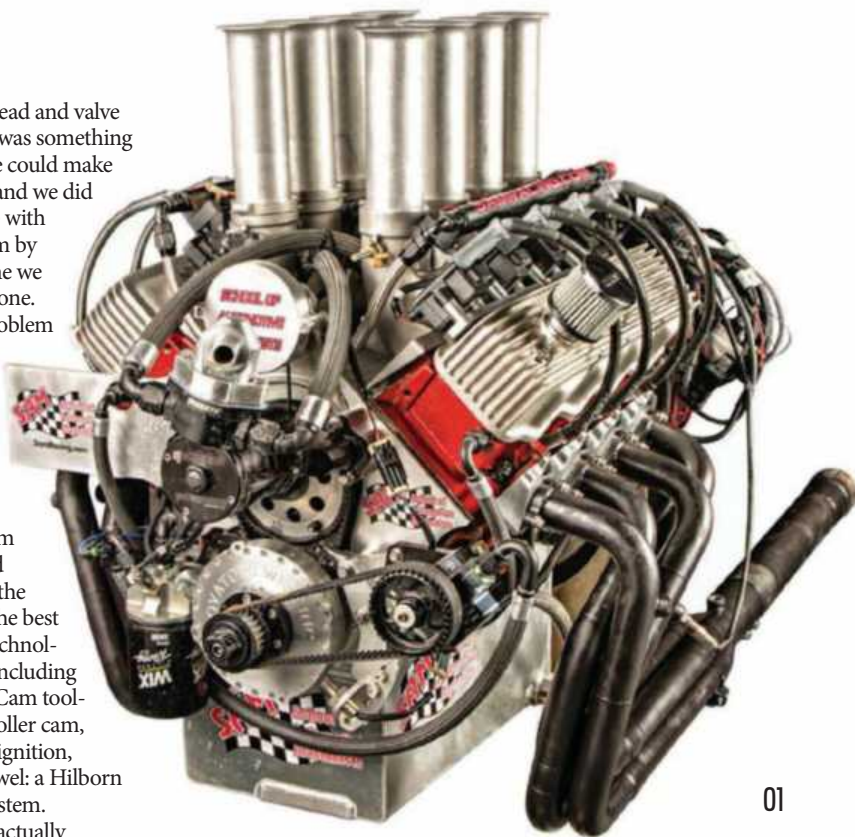
these engines originally was a horrible intake manifold and a very small carb." The school's build team of instructors and students dressed the engine out with the best of what today's technology has to offer, including a custom Comp Cam tool-steel core, solid-roller cam, Holley's EFI and ignition, and the crown jewel: a Hilborn stack injection system.

The stacks are actually manufactured for a Chevy LS7 application, which happens to match the port spacing of the Poly nearly perfectly. As SAM team member Chris Bennet puts it, "We take everything to the extreme and go all out in a competition like this." On the dyno, SAM's 402ci Poly showed 547 peak horsepower at 5,800 rpm, while torque came in strong and early, registering 566 lb-ft at 3,800 rpm.

01 As all the competitors' engines were getting set on the dyno carts, the School of Automotive Machinists Vintage entry turned the most heads.

02 Like the LS7 that lent its intake to the build, the Poly uses coil-on-plug ignition.

03 It looks a lot like mechanical fuel injection; but it's the manifold for a MAP sensor to read manifold pressure under the throttle blades.



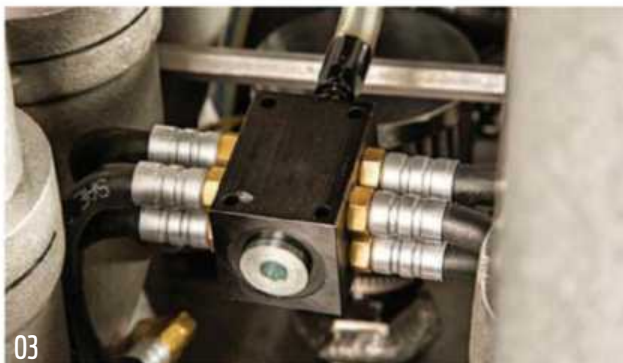
01



| | |
|--|--|
| ENGINE BUILDER | Chris Bennet, Anthony Kinney, Corbin Dale, Travis Hilger |
| ENGINE TYPE | Chrysler Poly |
| CLAIMED DISPLACEMENT | 402 ci |
| BLOCK | Factory cast iron |
| COMPRESSION RATIO | 13.0:1 |
| CRANKSHAFT | Eagle |
| CONNECTING RODS | Carrillo |
| PISTONS | CP |
| RINGS | Total Seal |
| CAMSHAFT | Comp Cams solid roller 230/234 duration |
| CYLINDER HEADS | Factory Iron, ported by SAM |
| INTAKE MANIFOLD | Hilborn Chevrolet LS7 individual runner Hilborn EFI |
| CARBURETOR OR EFI SYSTEM | Holley EFI |
| HEADERS | Custom-built |
| AMSOIL OIL | 10W-30 |
| AVERAGE PEAK HORSEPOWER OVER THREE PULLS | 547 hp |
| AVERAGE PEAK TORQUE OVER THREE PULLS | 566 lb-ft |



02



03

362ci

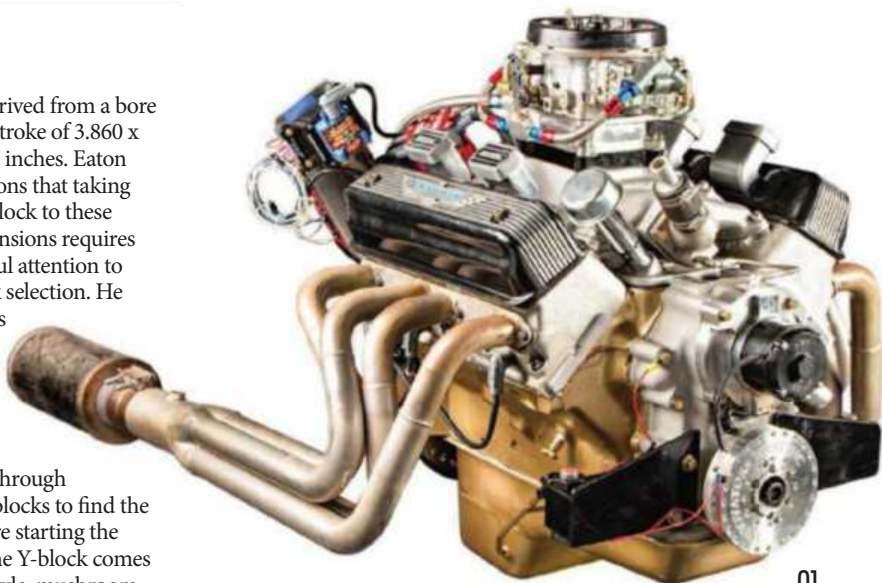
FORD Y-BLOCK

When the Ford Y-block over-head-valve engine came on the scene in 1954, it was the replacement for the long-running and beloved Ford flathead V8. With its odd vertically stacked intake ports, shaft-rocker system, and deeply skirted crankcase, the new engine was quite a departure from its predecessor and unconventional by the standards of the day. This engine series lasted through a 10-year product cycle before being discontinued in 1964, as the FE and small-block took over the reins, but it endures through a cult-like following of dedicated enthusiasts. One of those enthusiasts, well known in the Y-block Ford world, is Ted Eaton of Eaton Balancing. When Eaton caught wind of the Vintage class competition at HOT ROD's 2015 AMSOIL Engine Masters Challenge, he realized this represented an ideal opportunity to showcase the Ford Y-block's performance potential.

Eaton's engine displaced 362

ci, derived from a bore and stroke of 3.860 x 3.860 inches. Eaton cautions that taking a Y-block to these dimensions requires careful attention to block selection. He favors the

292ci blocks as the strongest starting point, and in fact, he went through a stack of six blocks to find the best one before starting the build. Since the Y-block comes with a stem-style, mushroom-faced lifter, there's no practical way to run a roller cam. Eaton went with a custom Isky flat-tappet cam with 254/258 duration at 0.050 and delivering 0.620-inch lift. With Mummert aftermarket aluminum heads and intake, a Holley 1,050-cfm carb, and 1.7:1 Mummert lifters, the engine was equipped for power. Joe Crane, from San Antonio, Texas, performed a lot of head massaging. He told us that he bench flows each port individually—and since the ports are stacked, creating a different turn radius, that's a problem for good breathing heads. The old Ford responded well to the mods, recording 542 hp at 6,000 rpm and 496 lb-ft at 5,200 rpm.



01



| | |
|--|-----------------------------------|
| ENGINE BUILDER | Ted Eaton |
| ENGINE TYPE | Ford Y-Block |
| CLAIMED DISPLACEMENT | 363 ci |
| BLOCK | Factory cast iron |
| COMPRESSION RATIO | 13.0:1 |
| CRANKSHAFT | Moldex |
| CONNECTING RODS | Eagle |
| PISTONS | Diamond |
| RINGS | Eagle |
| CAMSHAFT | Isky flat-tappet 254/258 duration |
| CYLINDER HEADS | Mummert cast aluminum |
| INTAKE MANIFOLD | Mummert |
| CARBURETOR OR EFI SYSTEM | Holley |
| HEADERS | Custom-built |
| AMSOIL OIL | 10W-30 |
| AVERAGE PEAK HORSEPOWER OVER THREE PULLS | 539 hp |
| AVERAGE PEAK TORQUE OVER THREE PULLS | 492 lb-ft |

01] This engine wouldn't look out of place in a Thunderbird's engine bay

02] Mummert is just about the only source for aluminum intakes and heads for Y-blocks, and they did the job, bringing the small-bore V8's power numbers into the 21st century.

PICK THE RIGHT BLOCK

Ted Eaton went through six blocks to find one good one. Core shift, over-bored cylinder walls, cracks in the water jacket of the cam tower, and broken ears are just some of the things you should look out for. You should also look for the later-1961 truck blocks, which have extra webbing. John Kaase's Y-block (on page 40) also uses the stouter webbed truck block. Eaton sonic tests all blocks before machining.

FYI, the fastest Y-block to date is Keith Cornell's 188-mph blast in his Rolling Bones roadster at Bonneville.



02

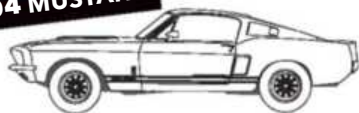
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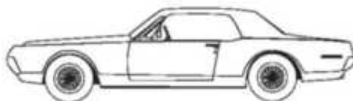
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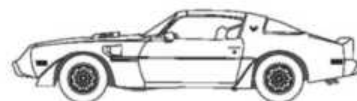
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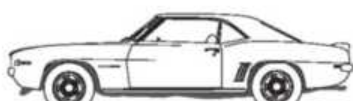
67-73 COUGAR



67-81 FIREBIRD / TRANS AM



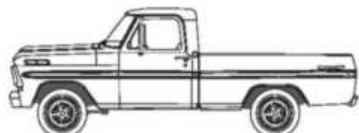
79-93 MUSTANG



67-81 CAMARO



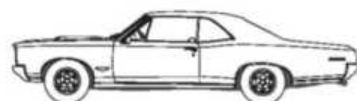
64-87 CHEVELLE
MALIBU / EL CAMINO



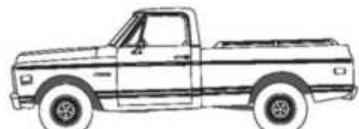
48-96 F-SERIES TRUCK



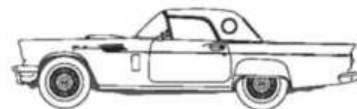
66-96 FORD BRONCO



64-72 GTO / TEMPEST / LEMANS



47-98 CHEVROLET
C/K - 1/2 TON TRUCK



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CALIFORNIA DEPOT
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1376 Walter St #1
Ventura, CA 93003



383ci

LINCOLN Y-BLOCK

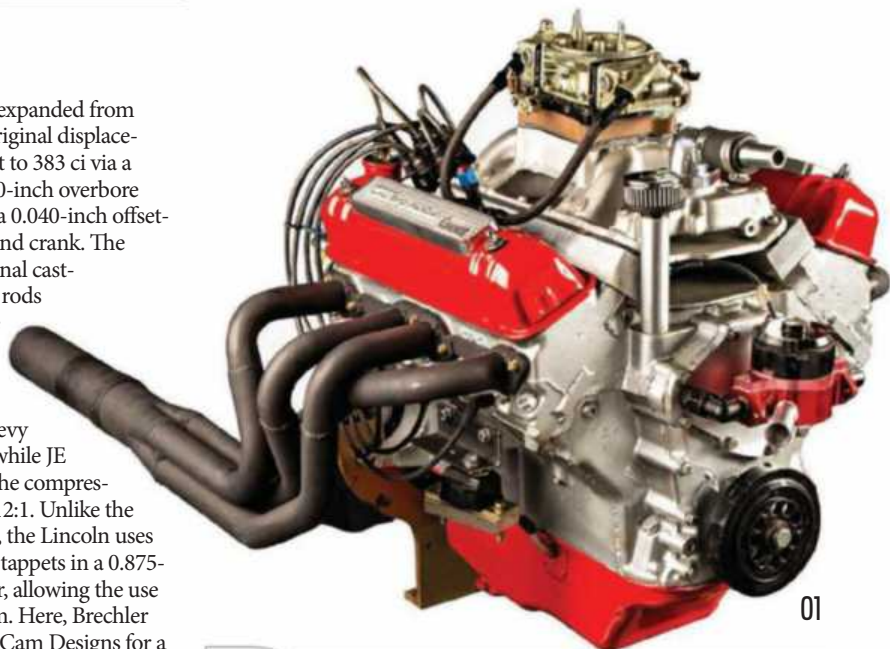
The RB Vintage Y-block entry at the 2015 AMSOIL Engine Masters Challenge is not the same breed as other Ford versions. The engine featured here is a Lincoln Y-block, which was an entirely different animal, and a much larger engine, sometimes referred to as the "big-block" Y-block. The Lincoln engine was introduced in 1952, and production ran through 1957 in passenger cars and 1963 in medium-duty trucks. Displacement ranged from 279 to 368 ci. The main disadvantage when trying to squeeze more power from Lincoln's version of the Y-block is that there is and was virtually no aftermarket support. Ever. If there's an advantage, it's that the heads don't have stacked ports like the Ford, which should give the Lincoln an edge in the breathing department. That is, unless you machine an entirely new intake port arrangement.

Royce Brechler of RB Vintage based his entry on the very rare 1957 Mercury Turnpike Cruiser 368ci V8, a one-year option in those vehicles. Brechler's engine

was expanded from its original displacement to 383 ci via a 0.060-inch overbore and a 0.040-inch offset-ground crank. The original cast-steel rods were

replaced by 7.100-inch Scat big-block Chevy forged rods, while JE pistons take the compression ratio to 12:1. Unlike the Ford Y-block, the Lincoln uses conventional tappets in a 0.875-inch diameter, allowing the use of a roller cam. Here, Brechler tapped Jones Cam Designs for a custom roller with 252 degrees duration and 0.625-inch lift. Rockers are custom Harland Sharp's, in a 1.6:1 ratio. Adaptor spacers mate an Edelbrock small-block Chevy AirGap intake to the surprisingly advanced OEM Lincoln iron cylinder heads.

So was the Lincoln Y-block some sort of strange anomaly? It is all but forgotten, with potential only the initiated inner circle recognize. With Brechler's performance of 463 hp and 467 lb-ft at the 2015 AMSOIL Engine Masters Challenge, the Lincoln's might is put into the spotlight for all to see.



01



| | |
|--|--|
| ENGINE BUILDER | Royce Brechler |
| ENGINE TYPE | Lincoln Y-Block |
| CLAIMED DISPLACEMENT | 383 ci |
| BLOCK | Factory cast iron |
| COMPRESSION RATIO | 12.0:1 |
| CRANKSHAFT | Offset-ground stock forging |
| CONNECTING RODS | Scat |
| PISTONS | JE |
| CAMSHAFT | Jones Cam Designs solid roller 252 duration |
| CYLINDER HEADS | Factory Lincoln, ported by Joe D. Craine |
| INTAKE MANIFOLD | Edelbrock Performer RPM small-block Chevy tunnel ram |
| CARBURETOR OR EFI SYSTEM | Holley HP Ultra 750 CFM |
| HEADERS | Schoenfeld 1 1/2"-1 1/8" |
| AMSOIL OIL | 10W-30 |
| AVERAGE PEAK HORSEPOWER OVER THREE PULLS | 462 hp |
| AVERAGE PEAK TORQUE OVER THREE PULLS | 467 lb-ft |

01 Although we wanted to, no bonus points were awarded for having the coolest valve covers of the competition.

02 The Edelbrock AirGap intake plus the aluminum adapters gave the intake a mini tunnel-ram effect.

03 Sizable standoffs were used to adapt a small-block Chevy intake manifold.

02



03

400ci FORD Y-BLOCK

When legendary AMSOIL Engine Masters participant Jon Kaase considered the new Vintage V8 class for the 2015 Challenge, he contemplated engine possibilities with the cold pragmatism of a serious competitor. One of the key requirements from Kaase's perspective was the availability of an aluminum cylinder head. As Kaase explains, "An aluminum head allows almost unlimited modifications, and in an unlimited class like this year's Vintage category, we wanted a head that can be machined and welded or modified." Modify they did, with more than 10 pounds of welding rod reconfiguring the head to eliminate its most troublesome characteristic: stacked ports.

Yes, rather than having side-by-side intake ports (like nearly every other American V8), the Ford Y-block head has its ports stacked in pairs. Kaase completely reconfigured the head to give the fuel an unobstructed path to combustion glory. With a small-block Chevy intake adapted to the block, and side-by-side intake ports, it's almost as if Kaase started with a Y-block and finished with a small-block Chevy.

Topping the Mummert heads is a custom adapter mating the heads to a tall Edelbrock small-

block Chevy tunnel ram. The bottom end was built with a Bryant billet crank, Carrillo rods, and custom Diamond pistons. The result is a 400ci engine putting the squeeze on the mix at a

13.9:1 ratio. To work with the mushroom-tappet arrangement of the Ford Y-block, custom lifters were manufactured by Trend, with a Comp Cams billet flat-tappet cam orchestrating the movement. Kaase custom-fabbed a long set of tri-Y headers and installed an MSD ignition system to light it off. Another aspect of this 400ci engine revealed during teardown is the unique oil system with nylon lines and Parker Prestolok ends. Through a nifty bit of machine work and construction of the log, the lines bring extra oil to the lifters. In effect, any deficiency in oil for any vintage engine can be overcome with this type of relatively straightforward setup.

So what is the effect of all of these mods on this ancient Ford? How about numbers that would leave any builder of the latest hardware slack-jawed at the results. Torque started off strong at 526 lb-ft at the 3,000 rpm bottom of the test range, and twist only ramped up from there. Peak torque recorded measured 596 lb-ft at 4,600 rpm. On the power side, Kaase didn't disappoint, with peak output showing 584 hp at just 5,500 rpm. That was plenty of power and torque over the rpm range to net a class-winning score.



01



02

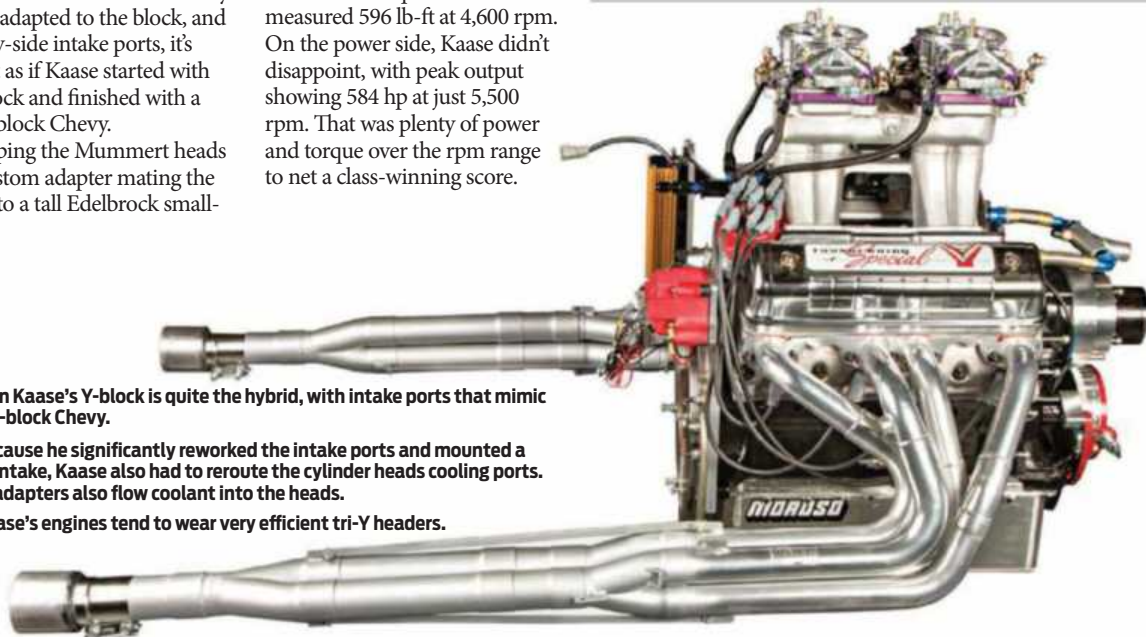


| | |
|--|---|
| ENGINE BUILDER | John Kaase |
| ENGINE TYPE | Ford Y-Block |
| CLAIMED DISPLACEMENT | 400 ci |
| BLOCK | Factory cast iron |
| COMPRESSION RATIO | 13.9:1 |
| CRANKSHAFT | Bryant |
| CONNECTING RODS | Carrillo |
| PISTONS | Diamond |
| RINGS | Eagle |
| CAMSHAFT | Comp flat-tappet 244/238 duration |
| CYLINDER HEADS | Mummert |
| INTAKE MANIFOLD | Edelbrock 7110 small-block Chevy tunnel ram |
| CARBURETOR OR EFI SYSTEM | Two Holley 750 cfm |
| HEADERS | Dynatech 1 1/8 to 2-inch stepped tri-Y |
| AMSOIL OIL | 10W-40 |
| AVERAGE PEAK HORSEPOWER OVER THREE PULLS | 584 hp |
| AVERAGE PEAK TORQUE OVER THREE PULLS | 596 lb-ft |

01] John Kaase's Y-block is quite the hybrid, with intake ports that mimic a small-block Chevy.

02] Because he significantly reworked the intake ports and mounted a Chevy intake, Kaase also had to reroute the cylinder heads cooling ports. These adapters also flow coolant into the heads.

03] Kaase's engines tend to wear very efficient tri-Y headers.



03

568hp

FROM AN LS3 WITH
LS7 TOP END

The School of Automotive Machine (SAM) team has built an enviable reputation for building power with GM's LS-series engines. The LS class of competition this year began with complete Chevrolet Performance LS3 crate engines. The object here is for a competitor to bring a complement of high-performance parts to create a power package that works with the stock, untouched GM short-block. This opens the door to cam, valvetrain, cylinder-head, induction, and exhaust mods—along with aftermarket EFI. The kicker is the parts must work with the stock bottom-end, and the parts need to be assembled to the engine onsite during the competition.

The SAM team went with the works, starting with the airflow system. The backbone is its own CNC-ported version of the CID Pro-Port LS7 castings, topped

by a mildly modified MSD Atomic Air Force intake and a Holley 105mm throttle-body. Fully

tunable control is achieved with a Holley EFI system, running 83-lb/hr injectors. The large injectors allow for a lower duty cycle, giving the team some ability to work fuel phasing, particularly at lower rpm. High-rpm power is ensured with a hot Comp hydraulic roller measuring 236 degrees at 0.050 and delivering 0.650-inch lift via 1.8:1 Jesel shaft rockers. American Racing headers pipe the exhaust to complete the power combo.

The SAM's team parts seemed to deliver the goods, with the 6.2L Chevy spinning the dyno to 512 lb-ft of peak torque at 5,100 rpm, while horsepower turned the dial to a recorded 568 peak horsepower at 6,300 rpm.

01 One benefit of the newer polymer intakes is their ability to mount huge throttle-bodies, like this Holley 105mm unit. This is the race version, with no taper on the throttle bore to help part-throttle driveability; it's all about wide-open with this one.

02 MSD's Atomic Air Force intake has proven to be among the best polymer intakes on the market, posting better numbers than many high-rise aluminum pieces.



| | |
|--|---|
| ENGINE BUILDER | School of Automotive Machinists, Shawn Hooper |
| ENGINE TYPE | Chevrolet Performance LS3 |
| CLAIMED DISPLACEMENT | 376 ci |
| BLOCK | Factory cast aluminum |
| COMPRESSION RATIO | 11.4:1 |
| CRANKSHAFT | Chevrolet |
| CONNECTING RODS | Chevrolet |
| PISTONS | Chevrolet |
| RINGS | Chevrolet |
| CAMSHAFT | Comp hydraulic roller 236/236 duration |
| CYLINDER HEADS | CID LS7 ported by SAM |
| INTAKE MANIFOLD | MSD Atomic Air Force |
| CARBURETOR OR EFI SYSTEM | Holley EFI |
| HEADERS | American Racing 1½ to 1¼ |
| AMSOIL OIL | 0W-20 |
| AVERAGE PEAK HORSEPOWER OVER THREE PULLS | 567 hp |
| AVERAGE PEAK TORQUE OVER THREE PULLS | 510 lb-ft |



01



02

577hp

LS3 USING SUV PARTS

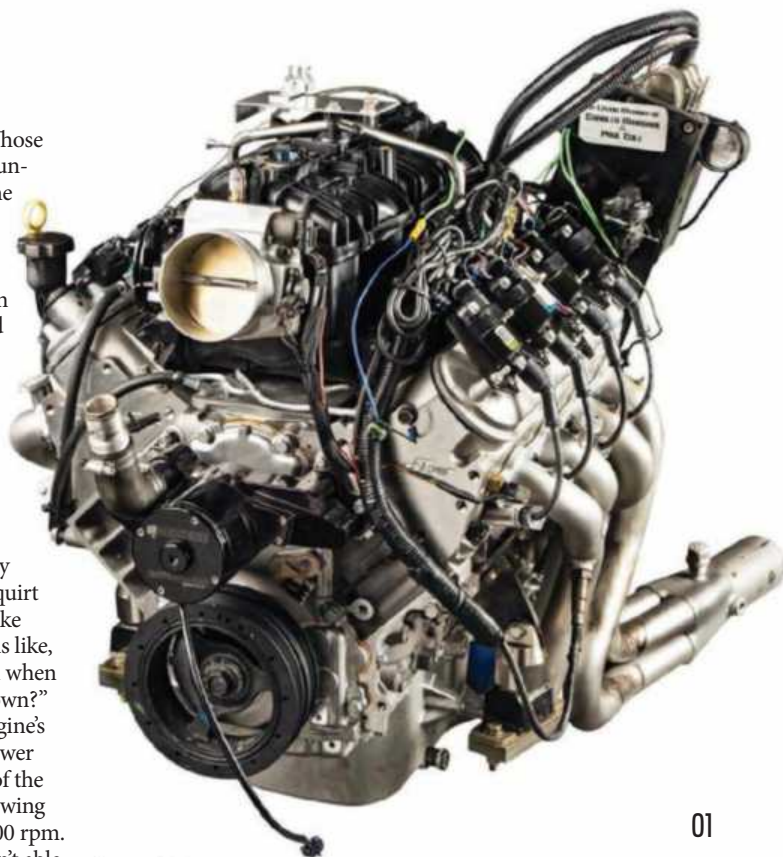
These dyno contests tend to attract a rare breed of enthusiast—engine guys who think out of the box and buck convention to do things their own way. Dave Storlien of Porting Dynamics is one of those guys, a guy not afraid to take an original approach to an engine-build project. For the 2015 AMSOIL Engine Masters Challenge, Storlien entered the LS3 Bolt-On Shootout competition with the idea of maximizing torque. To that end, Storlien decided to forgo the available aftermarket intake manifolds and opted for the L92 piece from a Cadillac Escalade SUV. This unlikely intake carries the larger rectangular ports, akin to an LS7, but in a layout factory engineered for torque. A custom Comp Cams hydraulic-roller cam was cut to Storlien's specs of 234/245, on a wide 114-separation angle, and installed straight up at 114

degrees. Those specs are unusual in the competition, but you can bet Storlien considered

each valve time event with deliberation.

The unconventional manifold—at least for competition—feeds air to a set of out-of-the-box Trick Flow cylinder heads, while a homemade speed-density EFI system from MegaSquirt provides the fuel. Guys like Storlien ponder questions like, “Why buy an EFI system when you can just build your own?” In testing, despite the engine's focus on torque, peak power was actually well ahead of the previous competitor, showing 577 hp on the dial at 6,700 rpm.

The powerful LS3 wasn't able to collect a score, however, as disaster struck when the engine refused to turn the dyno past the 7,400-rpm mark on its final scoring run, hanging just shy of the 7,500 rpm required to complete the pull. Trapped at near redline rpm for what seemed an eternity, the engine had crankcase blow-by and literally burst into flames, ending Storlien's shot at a win.



01

01] Dave Storlien's entry was a definite sleeper. At a glance, the L92 truck intake could let the LS3 be mistaken for a garden-variety 5.3L.

02] To squeeze out as much power as possible, competitors run electric water pumps. Meziere was the go-to for many competitors.

03] Unported Trick Flow 255X heads proved to be capable of 577 hp, the highest of our three competitors.



| | |
|--|---|
| ENGINE BUILDER | Porting Dynamics, Dave Storlien |
| ENGINE TYPE | Chevrolet LS3 |
| CLAIMED DISPLACEMENT | 376 ci |
| BLOCK | Factory cast aluminum |
| COMPRESSION RATIO | 11.45:1 |
| CRANKSHAFT | Chevrolet |
| CONNECTING RODS | Chevrolet |
| PISTONS | Chevrolet |
| RINGS | Chevrolet |
| CAMSHAFT | Comp Cams hydraulic roller 234/245 duration |
| CYLINDER HEADS | Unported Trick Flow 255X |
| INTAKE MANIFOLD | Chevrolet L92 |
| CARBURETOR OR EFI SYSTEM | MegaSquirt EFI |
| HEADERS | Hooker 1 1/4 |
| AMSOIL OIL | 0W-20 |
| AVERAGE PEAK HORSEPOWER OVER THREE PULLS | 573 hp |
| AVERAGE PEAK TORQUE OVER THREE PULLS | 499 lb-ft |



02



03

578hp

LS3: BIG HEADS & SMALL CAM

With extensive experience and development time on the LS engine platform to their credit, the School of Automotive Machinists (SAM) was eager to fill an additional available spot on the roster in our LS class. Some of the parts of the school's two entries were similar, including the MSD intake manifold and ignition components, but the two LS entries couldn't have been more different. This engine featured a much larger PRC LS7-style head with larger ports, valves, and increased cross-sectional area. Working with the bigger head, the specifications on the camshaft were dialed back. The end result is less cam and more head to do the same job as the school's other entry.

Through the course of the competition session, the engine

performed flawlessly, as the disciplined SAM team worked through the tuning process. Here their experience showed, with the Holley EFI quickly worked to a perfect tune. Despite the SAM patriarch Judson Massingill's opinion that this engine would smoke the other combination on the dragstrip, it proved not to have the sauce to win the event. Showing an impressive 578 peak horsepower at 6,800 rpm, the engine easily out-powered the other combination in raw power. With HOT ROD's 2015 AMSOIL Engine Masters Challenge scoring system based on average power over the entire rpm range, this engine fell short of SAM's other entry—a small-head, big cam bolt-on LS effort—finishing in Second Place. The SAM team definitely showed their capabilities with LS engines, sweeping the top two positions.

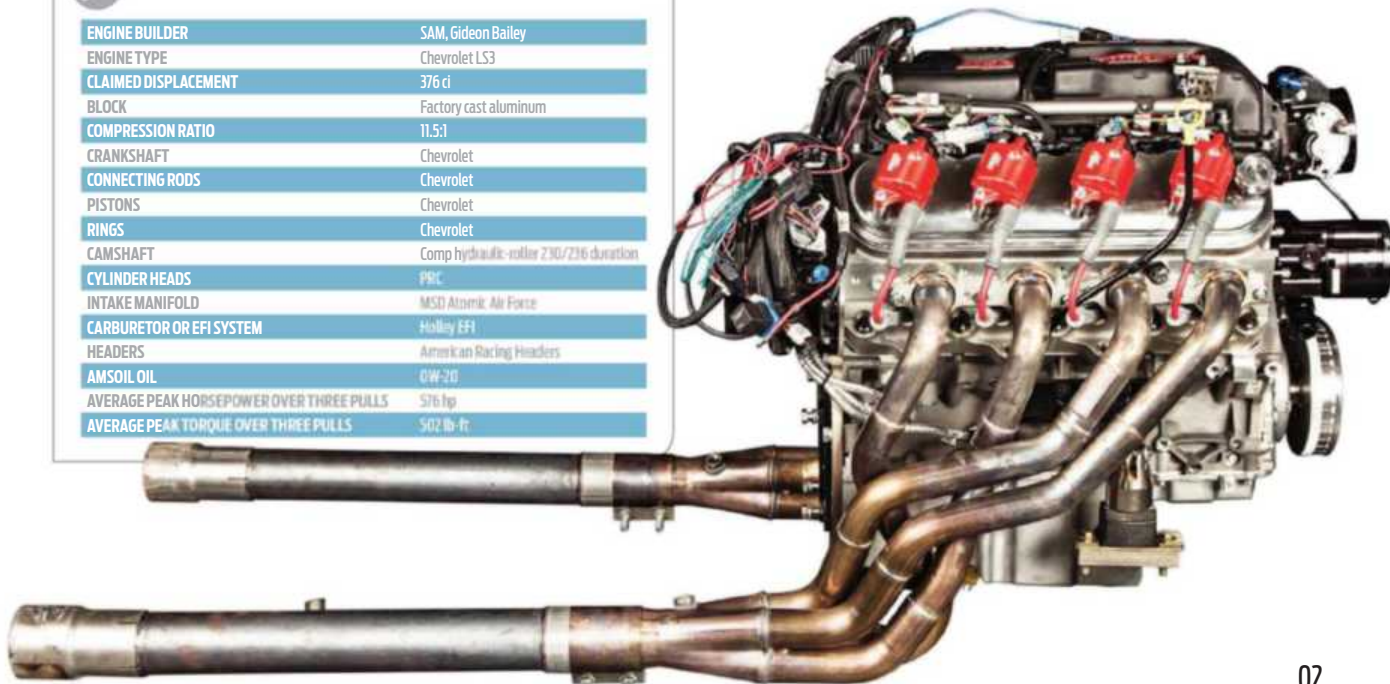


01

01 The SAM team's second entry looks a lot like their other engine; we swear, it's not the same one.

02 Long-tube American Racing Headers with 2-inch primaries provided a significant flow increase over the factory cast manifold.

| | |
|--|--|
| ENGINE BUILDER | SAM, Gideon Bailey |
| ENGINE TYPE | Chevrolet LS3 |
| CLAIMED DISPLACEMENT | 376 ci |
| BLOCK | Factory cast aluminum |
| COMPRESSION RATIO | 11.5:1 |
| CRANKSHAFT | Chevrolet |
| CONNECTING RODS | Chevrolet |
| PISTONS | Chevrolet |
| RINGS | Chevrolet |
| CAMSHAFT | Comp hydraulic-roller 230/236 duration |
| CYLINDER HEADS | PRC |
| INTAKE MANIFOLD | MSD Atomic Air Force |
| CARBURETOR OR EFI SYSTEM | Holley EFI |
| HEADERS | American Racing Headers |
| AMSOIL OIL | 0W-20 |
| AVERAGE PEAK HORSEPOWER OVER THREE PULLS | 576 hp |
| AVERAGE PEAK TORQUE OVER THREE PULLS | 502 lb-ft |



02

What Gets Your Motor Runnin'?

GEARHEAD

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ACTUALLY
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SATISFACTION GUARANTEED To assure a proper fit, a ring sizer will be sent to you after your reservation has been accepted.

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Signature _____

Mrs. Mr. Ms. _____

Name (Please Print Clearly)

Address _____

City _____

State _____

Zip _____

E-Mail (Optional) _____

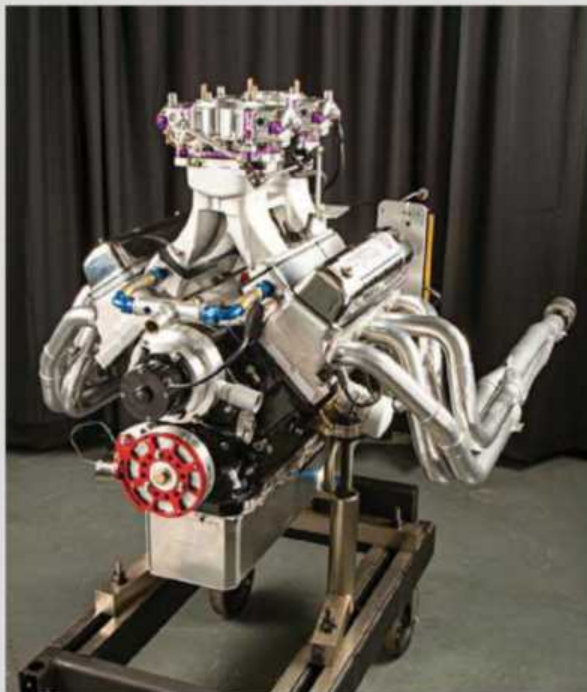
01-21537-001-E94701

SHOCKING! ANCIENT FORD ENGINE SMASHED CHEVY LS3 TORQUE NUMBERS



CHEVY LS3

Engine technology has advanced light years since the Y-block Ford was being developed in the early 1950s. Yet, for all of the advances in casting, metallurgy, computer-aided design, tuning, and mapping, the Jon Kaase-built, dual-quad Ford Y-block might make one think the torque numbers from the LS3 shootout look soft. Not to take anything away from those who made valiant efforts in the LS Bolt-On Shootout, but it would seem that what GM wrought during the last 15 years still can't trump good ol' hot rod V8 bench-press success when it packs a 24ci advantage. Let's look at the numbers: Yeah, the LS3 beats out the Y-block on horsepower, but take a look at the torque of the two engines. And peak torque for



FORD Y-BLOCK

the old Ford was just a hair less than 600 lb-ft!

And to top it off, the old Y-block has not been the hot rodder's friend. Hot rodgers went from Ford flatheads to Chevy small-blocks in a flash. So while there's too much available today to aid in increasing LS performance, until the more recent aluminum heads became available for the Y-block as a last-gasp Hail Mary to help the die-hard Ford Y-block fanatics, this engine just never registered on the hot rodder's hit list. Ever.

So have we experienced success in engine development over the last 65-plus years? After looking at the results, you tell HOT ROD.



| | |
|--|---------------|
| ENGINE TYPE | Chevrolet LS3 |
| CLAIMED DISPLACEMENT | 376 ci |
| AVERAGE PEAK HORSEPOWER OVER THREE PULLS | 576 hp |
| AVERAGE PEAK TORQUE OVER THREE PULLS | 502 lb-ft |



| | |
|--|--------------|
| ENGINE TYPE | Ford Y-Block |
| CLAIMED DISPLACEMENT | 400 ci |
| AVERAGE PEAK HORSEPOWER OVER THREE PULLS | 477.6 hp |
| AVERAGE PEAK TORQUE OVER THREE PULLS | 557 lb-ft |

Contacts

CHEVROLET PERFORMANCE PARTS; Grand Blanc, MI; 800.577.6888; ChevroletPerformance.com

MEZIERE ENTERPRISES; Escondido, CA; 800.208.1755; Meziere.com



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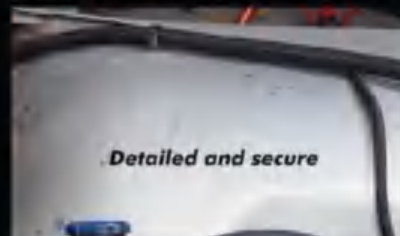
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Before



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10309 - 17 Circuit Customizable Nostalgia All Black Chassis Harness



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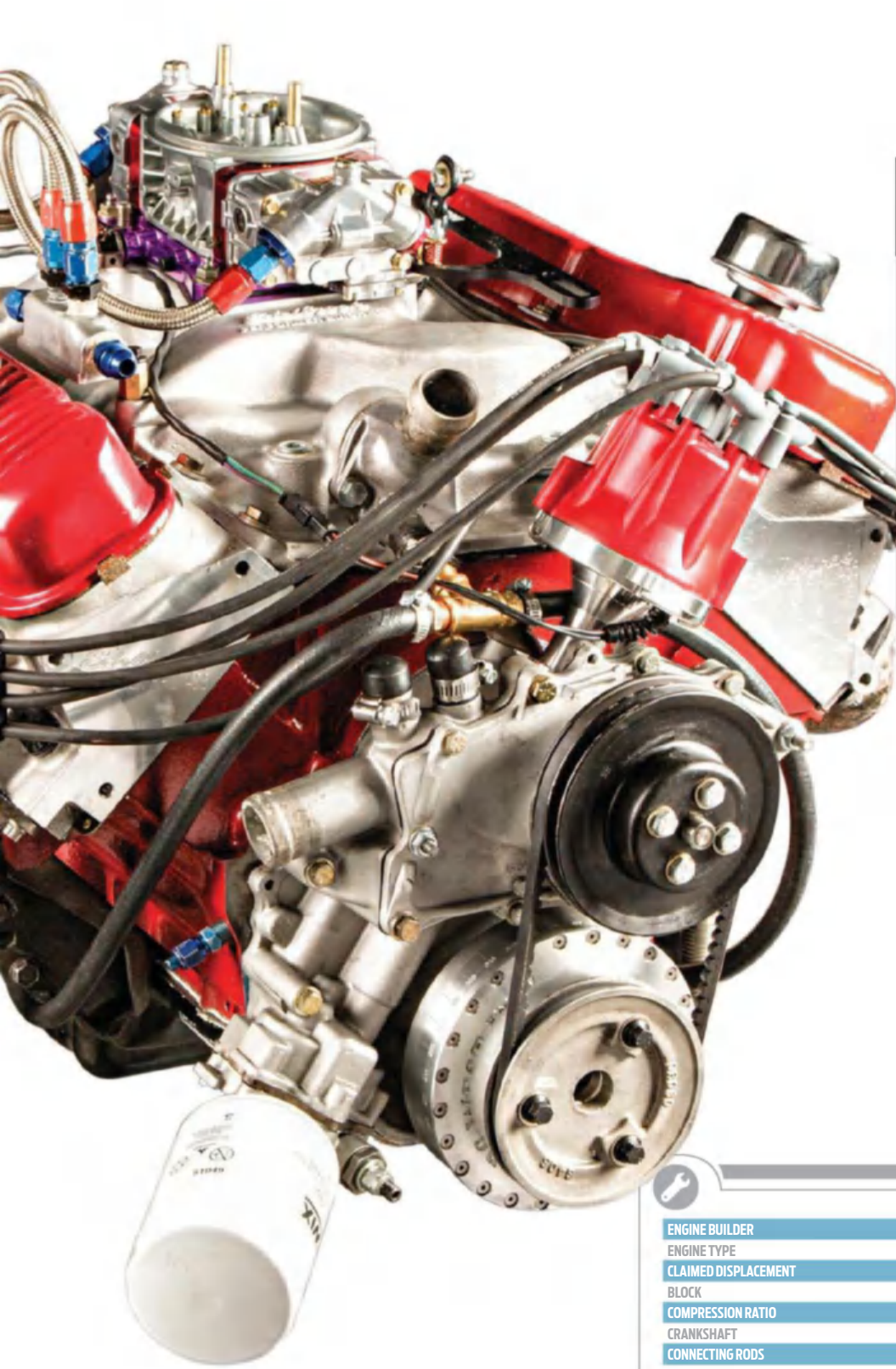
BUICK

A Buick may seem like an unusual choice for the Spec. Small-Block class of HOT ROD's 2015 AMSOIL Engine Masters Challenge, but with the factory 400 dimensions, it was possible to meet the bore-and-stroke maximum of 4.060x4.00 required in the competition. Spec. Small-Block class engines were required to run a specific Edelbrock cylinder-head casting, as well as an Edelbrock manifold. While the Buick cylinder head certainly had the potential to compete with the best of the other engine types, the Buick was handicapped by being the only engine for which the Edelbrock RPM Air-Gap intake manifold is not available. That meant the CP-Carrillo team was required to run the standard Edelbrock Performer intake. Bryce Mulvey and Ric Panneton built a custom bottom-end combina-

tion using a stock crank offset ground to a Chevy 2.200-inch rod journal diameter, bringing the stroke close to the spec 4.000-inch maximum. With a 6.525-inch Carrillo rod and a custom CP Bullet piston, the displacement worked out to 413 ci.

In the cell the CP-Carrillo team performed flawlessly, methodically working the tune, touching both the timing and the fuel mixture in several steps. The Buick responded with incremental increases in power with every change, as the calibration was zeroed in to meet the local conditions. When it was all said and done, the Buick delivered 542 peak horsepower at 6,400 rpm, while torque checked in at 484 lb-ft at 5,300 rpm.





BIG-BORE BUICKS

Buick big-blocks have a 4.750-inch bore spacing, smaller than Chevy's big-block at 4.840 inches. Yet the Buick 455 was available with a 4.31-inch bore, bigger than the Chevy 454's. They're also a lot lighter, due to their thin-wall casting. Production on Buick big-blocks ran from 1967–1976, as GM's B-body cars got significantly lighter for 1977 and the largest engine available in a Buick was the 403ci Olds V8.

01] The factory valve covers belie the power that's hiding in the mild-looking Buick.

02] The CP-Carrillo team made some jet changes between runs, along with timing adjustments.



| | |
|--|---|
| ENGINE BUILDER | CP-Carrillo R&D |
| ENGINE TYPE | Buick 400 ci |
| CLAIMED DISPLACEMENT | 414 ci |
| BLOCK | Factory iron |
| COMPRESSION RATIO | 10.9:1 |
| CRANKSHAFT | Factory iron |
| CONNECTING RODS | Carrillo Bullet |
| PISTONS | CP Bullet |
| RINGS | CP |
| CAMSHAFT | Comp hydraulic-roller 265/268 duration |
| CYLINDER HEADS | Edelbrock Performer |
| INTAKE MANIFOLD | Edelbrock Performer |
| CARBURETOR OR EFI SYSTEM | 1,050-cfm Holley |
| HEADERS | TA Performance 1 1/8- to 3 1/2-inch collector |
| AMSOIL OIL | 0W-20 |
| AVERAGE PEAK HORSEPOWER OVER THREE PULLS | 540 hp |
| AVERAGE PEAK TORQUE OVER THREE PULLS | 482 lb-ft |

414ci

FORD WINDSOR

To show you how crazy HOT ROD's AMSOIL Engine Masters Engine Challenge can be, Randy Malik has competed in all of them and says it's his "vacation, but not fun." He takes one week off every year building engines at his RM Competition in Roseville, Michigan, and spends it competing in the Challenge. This year he brought a small-block Ford to compete.

"Building engines is what I do, and this is the culmination of all that I do," he says. "You don't deal with transmissions, or tires—the car is not involved, it's just the engine and I'm an engine builder." But the weird thing is he says he doesn't have fun doing this. Say what?

"It is stressful, but it's the most enjoyable week of the year for me," Malik says. "You get away from the shop and you don't worry about what's going on—you get to worry about your own stuff for a week."

He says part of doing HOT ROD's AMSOIL Engine Masters Engine Challenge is first going through your stuff to see what you can put together from what you have versus what parts you have to buy. "So if it's going to cost me \$15,000 to build a Cleveland or \$9,000 to build a Windsor, I'm building a Windsor, even if it's not as good," he says. "If I had doctors' money, I'd build a Pontiac engine, but I can't afford that."

Malik is fairly pragmatic about what works and what will win at the Challenge. He says the rules (in his Spec. Small-Block class) state you have to run a Performer RPM Edelbrock head and that the Buick is the best head, and the Pontiac is the second-best head.

"The cylinder head is the whole game," he says. "Combustion-chamber activity, velocity, and flow, all encased in a certain cylinder head makes the best head." He also likes to run his engines rich at low rpm for competition at the Challenge. "It's not so good on a street engine, but this is the Challenge," he says. "You might only gain 2 hp, but it's 2 hp at Engine Masters, so it makes a difference. Your only numbers that matter are horsepower and torque."

Malik came to HOT ROD's 2015 AMSOIL Engine Masters Challenge Spec Small-Block class with a 414ci Ford Windsor engine combo. Malik handled the port development on the Edelbrock cylinder heads, which were modified to flow approximately 300 cfm at peak intake flow. Working with Modern Cylinder heads, Malik's prototype port was scanned and then the heads were CNC-ported by Modern. Likewise, Malik extensively modified the Edelbrock Performer RPM Air-Gap intake manifold with hand-porting, opening the casting as much as possible without breaking through the outside walls.


The camshaft choice here was unusual, with a lobe-separation angle of 111 degrees, bucking the trend toward narrow separations most competitors favor. Malik tells us this cam worked most efficiently when installed at 109 degrees intake centerline. The idea clearly had merit, since there was a huge rpm range between peak torque rpm and the peak power rpm.

The engine ran cleanly and was making 571 peak horsepower at 6,700 rpm, while a peak of 538 lb-ft of torque was on hand at 4,400 rpm. This was not quite enough to challenge the Kaase team's Cleveland for first position, but it was enough to grab Second Place.



01 There weren't a lot of trick parts in this high-performing engine, just some solid porting and a custom-grind cam. Even the rings were parts-store OEM replacements.

02 Ford Racing headers are an off-the-shelf part too.

| | |
|---|---------------------------------|
|  | |
| ENGINE BUILDER | Randy Malik |
| ENGINE TYPE | Ford Windsor |
| CLAIMED DISPLACEMENT | 414 ci |
| BLOCK | Factory Iron |
| COMPRESSION RATIO | 10.9:1 |
| CRANKSHAFT | Factory iron |
| CONNECTING RODS | SCAT |
| PISTONS | Race-Tec |
| RINGS | Stock replacement, 0.060-over |
| CAMSHAFT | Comp 256/262 duration |
| CYLINDER HEADS | Edelbrock Performer |
| INTAKE MANIFOLD | Edelbrock Performer RPM Air-Gap |
| CARBURETOR OR EFI SYSTEM | 1,050-cfm Holley |
| HEADERS | Ford Racing |
| AMSOIL OIL | 5W-20 |
| AVERAGE PEAK HORSEPOWER OVER THREE PULLS | 567 hp |
| AVERAGE PEAK TORQUE OVER THREE PULLS | 536 lb-ft |

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415ci

FORD CLEVELAND

Chris Thomas from John Kaase Racing Engines put together a 415ci Cleveland using a set of ported Edelbrock heads that were milled to give the Edelbrock intake a better shot into the intake ports. Taking 0.125 inch off the heads resulted in a 40cc chamber that necessitated a dished piston to meet the class-required compression ratio, although it seems the plan worked, as the engine pulled hard and made more than 500 lb-ft of torque from the initial

recording at 3,500 rpm and kept it above that mark all the way to 6,000 rpm. That flat torque curve also meant a nice 1,600-rpm band between the torque peak of 554 lb-ft at 4,500 rpm and the 576hp peak at 6,100 rpm.

That impressive performance put the Cleveland on top of the HOT ROD's Spec Small-Block class with a score of 1,018,700 and an engine, from carb to header, that will bolt right into a 1969 or 1970 Mustang.

01 While there's still no charging system producing any parasitic loss, the Spec. Small-Block class called for a belt-driven water pump, making these engines virtually street-ready. The Cleveland used an Edelbrock aluminum water pump driven by a Jones Racing Products cogged-belt.

| | |
|--|--------------------------------------|
| ENGINE BUILDER | Chris Thomas, Almost Kaase |
| ENGINE TYPE | Ford Cleveland |
| CLAIMED DISPLACEMENT | 415 ci |
| BLOCK | Factory iron |
| COMPRESSION RATIO | 10.84:1 |
| CRANKSHAFT | Scat |
| CONNECTING RODS | Scat |
| PISTONS | Diamond |
| RINGS | Total Seal Gapless |
| CAMSHAFT | Comp flat-tappet 251/255 duration |
| CYLINDER HEADS | Edelbrock Cleveland 2V Performer RPM |
| INTAKE MANIFOLD | Edelbrock Performer RPM Air Gap |
| CARBURETOR OR EFI SYSTEM | 1,050-cfm Holley |
| HEADERS | Hooker 1 7/8, fits 1969 Mustang |
| AMSOIL OIL | 10W-30 |
| AVERAGE PEAK HORSEPOWER OVER THREE PULLS | 575 hp |
| AVERAGE PEAK TORQUE OVER THREE PULLS | 553 lb-ft |

02 Chris Thomas stands next to his class-winning engine. Thomas has had a hand in many winning entries at Engine Masters Challenge as part of the Jon Kaase Racing Engines team.

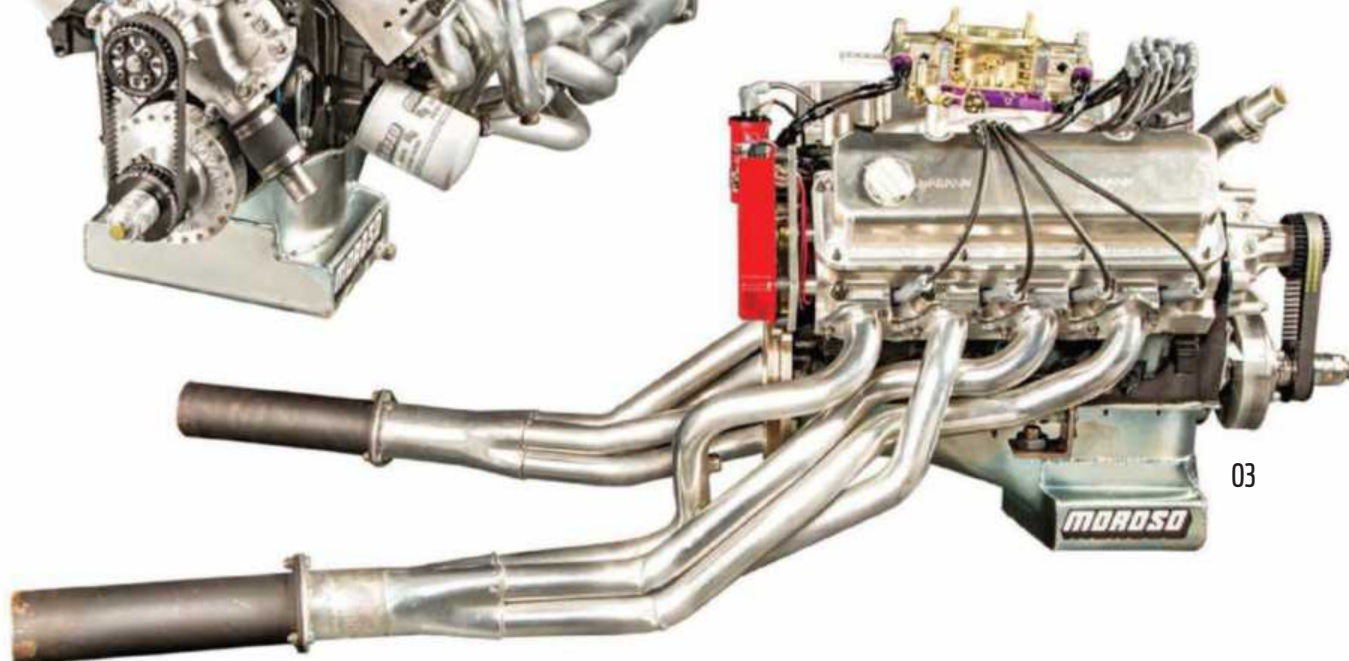
03 The 1 7/8-inch primary headers from Hooker are for a 1969–1970 Mustang. Their long primary tubes proved to help keep the torque steady between 4,500–6,100 rpm to score big points.



01



02



03



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► With all the different engine and combustion theories being tested at the Engine Masters Challenge, it made us wonder about the fuel these powerplants were gulping down. For the 2015 event, we had nearly 500 gallons of VP Racing's VP101 fuel on hand for our testing, and after spending the week converting this 101-octane, street-legal fuel into horsepower, we spoke with the engineers at VP Racing to talk compression ratios, chemistry, and the differences between street- and race-based hydrocarbons.

HR] Is racing fuel more than just high-octane street gas?

VP] Absolutely. Generally speaking, street gas is formulated to be as economical as possible while meeting the minimum standards required by government regulations. It all originates from the same network of pipelines before being modified in some cases by branded refiners. Its composition can vary depending on the source, the day of the week it's produced, as well as seasonally and geographically as dictated by government regulations for summer and winter blends. Currently, most street gas is blended with at least 10 percent ethanol. By contrast, VP race fuel starts with refined base stock to which we add pure chemical components, depending on the performance characteristics desired. Each race fuel is purpose-built with reliable consistency, i.e., no variation from batch to batch, month to month, or drum to drum.

HR] What advantages does racing fuel offer a car and engine?

VP] The first advantage is consistency, which is critically important to tuning. Matching the correct fuel with the application enables the engine to deliver its optimum performance. Higher octane, oxygenation, higher energy value, superior burning speed, and other factors enable increases in compression, timing changes, and other adjustments to maximize power and torque. Race fuel also offers better vaporization, more efficient combustion, and a cleaner burn—which helps suppress engine temperatures, results in less wear on the engine, permits longer intervals between rebuilds, and extends engine life. In evaluating whether to purchase

FUEL SPECS

| | |
|----------------------------|----------------------------|
| FUEL NAME | VP101 |
| TYPE | Unleaded |
| SPECIFIC GRAVITY | 0.713 at 60 degrees F |
| COLOR | Orange |
| MOTOR OCTANE | 97 |
| R+M/2 | 101 |
| RON | 105 |
| RVP | 6.5 |
| OXYGENATED | Yes |
| OXIDATION STABILITY (MIN.) | 1,440+ |
| DISTILLATION | 10% evap. at 144 degrees F |
| | 50% evap. at 208 degrees F |
| | 90% evap. at 211 degrees F |
| | E.P. at 250 degrees F |
| AVAILABILITY | Sealed drums |

race fuel at all, or which race fuel to purchase, a driver must weigh its cost against its value in accomplishing the driver's objectives.

HR] How would a VP race fuel compare to, say, a 93-octane street gas with a ton of octane booster?

VP] First, higher octane does not necessarily equate to more power, and depending on the application and the manner in which the fuel is designed, it can actually have the opposite effect. Most octane boost products do not deliver much of an increase, with most promising an increase measured in octane *points*, i.e., one-tenth of an octane *number*. The increase in octane also varies with the octane rating of the fuel being boosted, with higher-octane fuel seeing smaller increases. Regarding race fuel, octane is just one of several characteristics important to a fuel's performance, in addition to burning speed, energy value, and cooling effect among others. A race fuel with higher octane is not necessarily a better fuel or guaranteed to make more power because of these other factors and the role they play in the application. Race fuels are designed for a particular application to make the most power subject to the applicable rules, which might place restrictions on lead, oxygenates, specific gravity, or volatility.

HR] How many racing fuels are available from VP: Gas? Methanol? Ethanol? Diesel?

VP] VP currently offers more than 70 fuel blends, including more than 60 leaded and unleaded gasoline blends; three methanol blends; one diesel racing fuel; nitromethane at various concentration levels; and ethanol blends, including E10, E15, E20, and a proprietary E85 called C85 that includes hydrocarbon components in addition to ethanol.

HR] Does a gallon of VP race fuel weigh more than a gallon of street gas?

VP] It depends on the fuel blend. For example, nitromethane weighs significantly more than street gas, while other fuels like C25, weigh much less. One influencing factor is the fuel's ethanol content. If race fuel has more than 10 percent ethanol, it likely will weigh more than street gas since ethanol is a heavier component. In some

cases, a heavier fuel can have a higher energy content, but not always.

HR] Where is VP Racing fuel available?

VP] VP's fuels are available through a network of about 2,000 dealers and distributors across North America. VP fuels are also becoming more conveniently available as part of a retail program in which gas stations and convenience stores are being branded as VP Racing Fuels. Most VP-branded stations carry 5-gallon pails of VP's off-road race fuel blends. A smaller number of stations offer VP101, VP's street-legal 101-octane unleaded fuel [the fuel used at Engine Masters Challenge], dispensed from the pump.

HR] Where is VP Racing fuel refined?

VP] VP is not a refiner. VP purchases refined base stock from various suppliers and blends it with a variety of chemicals from suppliers in the U.S. and around the world. VP's plant near San Antonio, Texas, could more accurately be characterized as a blending facility.

HR] Does VP racing fuel oxidize as quickly as street fuel does when a car sits in storage?

VP] Stability depends on the fuel blend and the components it contains. VP's fuels are formulated to be as stable as possible. Some conventional race fuels are more stable than street gas with a substantially longer shelf life, while some of our more exotic, high-energy race fuels can be less stable with a shorter shelf life.

HR] What are the most common factors that make a car need race fuel?

VP] The higher an engine's com-

pression, the more it will require a higher-octane race fuel. The need for race fuel can also be influenced by the engine's environment, with higher temperatures requiring higher octane and better-quality fuel.

HR] How much fuel can a regular person carry in their race trailer without needing a special placard?

VP] You can carry up to 1,000 pounds of fuel without requiring a placard, which typically equates to two 54-gallon drums.

HR] How long does VP fuel last in an open drum?

VP] As a general rule of thumb, if a fuel is resealed in its original container and stored in proper conditions, its shelf life will be at least one year if the fuel is oxygenated and two years for non-oxygenated fuels. That said, fuel can often

last much longer, with one example being a fuel that tested OK after eight years!

HR] Can race gas or oxygenated fuel make more power on low-compression (8:1) engines?

VP] Yes, both oxygenated and non-oxygenated fuels can be used to improve performance in low-compression, naturally aspirated engines. As an example, we achieved a 21hp increase in a stock 454 Chevy with Q16. An oxygenated fuel will generate the most power. With any of these fuel options, tuning adjustments will be required to optimize performance.

HR] How much is nitromethane these days?

VP] VP's retail price on nitromethane is currently \$795 for a 54-gallon drum.

HR] How much compression can you have with a good amount of boost (say, 15 psi) on E85?

VP] E85 at the pump is very inconsistent, so this is difficult to answer. At the pump, the ethanol content of E85 can range 60 to 85 percent, so it's hard to tune and its octane rating might vary. That said, a consistent, quality E85 fuel could likely handle up to 9:1 compression with 15 psi or possibly higher. While VP manufactures an E85 race fuel for some of our race series partners, it also offers C85, which includes some hydrocarbon components to make more power. Both are very consistent, with C85 offering more power than E85 at the pump.

HR] It seems like a lot of racers are running methanol, what are the advantages?

VP] The advantages of methanol include its relatively low cost, it can be somewhat more forgiving with tuning than some conventional race fuels, it makes good power, and is flexible enough to work in a range of low- to high-compression engines. A drawback of methanol is that it absorbs water from the atmosphere. Because it's corrosive, it requires a special fuel system and the associated expense. With a lower energy value than gasoline, twice as much fuel is required, which affects cost. This is also problematic in circle-track or road-racing applications, with methanol's higher burn-off rate having a significant impact on weight distribution and chassis setup.

HR] What's the highest octane race gas you sell?

VP] Our C16, C23, NO2, Q16, and VP Import are all rated as 120+ (R+M/2). Believe it or not, the technology of the machines used by the industry to measure octane has not been updated since the 1930s when it was anticipated that 120 would be the upper limit of any fuel formula. As a result, current fuels that exceed that level can only be reported as 120+ octane.

HR] What's your most popular fuel?

VP] C12 has been the go-to fuel for virtually every category of motorsports throughout VP's 40-year history, during most of which it was our best-selling fuel. Currently, VP sells more gallons of VP110 than any other fuel.

Octane 101

Gasoline Q&A With the Fuel Engineers Who Power Engine Masters Challenge

  Jason Sands

WESTWARD

It picks up the front tires—but not at the hit of the throttle—there's a slow rise, and then they hang there, way past the point you'd expect to see air beneath them. When they come down, the boosted hot rod trips the lights in the high-8-second range. That's pretty impressive for a race car, and it's even more astounding when you learn that driver Troy Clark built the Model A in his garage and has put more than 5,000 street miles on it last year alone!

✍ Elana Scherr and Eric Rood
📷 Alex Wong and Elana Scherr



HO(RSEPOWER)



You Only Get One Chance To Be a Part of the First Time

Not since the westward expansion had such a brave band of pioneers set off through the desert of the Southwest. Mechanized horses rather than oxen powered this wagon train. While the likelihood of death by starvation was low, there was still the possibility of being stranded in the wilderness should your steed suffer a fatal engine failure, or, you know, run out of gas.

If you follow HOT ROD's Drag Week™, then let's just say that Drag Weekend, presented by Gear Vendors and with Baer Brakes as the event's official brakes, had the same format but shortened to three days instead of five. If you're new to our street-legal race events, here's how Drag Weekend worked:

For three days, competitors in street-registered cars raced down the dragstrip going for the quickest elapsed time (e.t.) possible, making as many runs as they liked or time allowed. At the end of each day, each racer turned in their best timeslip and the lowest average of the e.t.s won the respective class. Of course, there was a catch: Each day found the racers at a new racetrack, which they had to drive to on a specific route, with no support vehicles or trailers—unless that trailer was being towed by their race vehicle. We started at Tucson Raceway, then headed to Wild Horse Pass Motorsports Park near Phoenix. From there, we made the long drive to Auto Club Speedway in Fontana, California. Some 967 miles in all.

There were 10 classes for Drag Weekend, and three of them had just a single entry, making the win simply a matter of finishing the drives. That's not to say there wasn't some great track action. Within the first hour in Tucson, Jeff Lutz ran through the quarter-mile in just 6.209 seconds at 243.77 mph

with his Pro Mod Camaro and everyone was excited to see if any of our other big dog Drag Week™ racers—Joe Barry in his 3,720-pound orange 1956 Chevy or Dave Schroeder in the nitrous-eating, 872ci Corvette—could get down in that range. The competition didn't last long, as Barry's car spit the head gaskets out and Schroeder did half-track burnouts. That's OK, though, because the best part wasn't the battle but the three teams working together in the pits. Lutz's co-driver, Scott Murray, was lining up Schroeder. Barry's wife, Michelle, and son, Joey, were helping Lutz in the pits. It was less like a race and more like a racing family reunion.

We welcomed some new racers to the family too. Jeff Bomyea went down the dragstrip and finished up with a 7.79-second average in a twin-turbo 1968 Camaro. Ben Berger brought a Nissan GT-R and gave Dodge SRT engineer Jim Wilder a rabbit to chase with his Hellcat Challenger. Readers might be surprised to hear that one of our newbies was none other than the creator of Drag Week™ and Drag Weekend, *Roadkill's* David Freiburger. Freiburger and Steve Dulcich brought out the Crop Duster and not only did they get the big-block 1970 Plymouth to the track in time to run but managed a 12.06 on the last day. Of course, by then they'd already put themselves out of competition and set the car on fire several times.

We could go on with track times, but odd as it seems to say about a race, the results weren't really the point. It was the journey and the companionship that everyone talked about on the last day. This wasn't the usual Drag Week™ torture test. It was a long weekend with your new best friends. You can see all the results on page 67, but the real story is in the following photos.



In the 1960s, a group of Dodge factory engineers tested new products on the racetrack with their own time and money. It's rare now to see a manufacturer's car at a grassroots event without a huge factory backing, but we think the original Ramchargers would have been proud to see Dodge vehicle development manager Jim Wilder and co-driver, electrical system lead engineer Paul Rodriguez, as they prepped what was practically a stolen factory Hellcat Challenger for three days of Dodge representation. We're being dramatic, of course—the guys had official permission to take the car, but they really had to fight for it. We have to give Dodge credit for sending a stock car out with no marketing protection and no guaranteed win. That said, Jim took home the quickest Mopar trophy with a 10.69 on the final day. Wilder swears up and down that every detail on the Hellcat is stock, except for the 18x11-inch, forged, three-piece rear wheels that replace the Pirelli-wearing 20-inchers normally on the car. The shorter, wider wheels are wrapped in Nitto 315/40R19 NT05R drag radials. Oh, and they took the seats and the air cleaner out of the car to get every advantage.

Fred Sirman's 1964 Ford F-100 wasn't fast, but it was awesome. He drove all the way from South Carolina in his 302-powered machine, and engaged in a three-day battle for not-the-slowest-racer title with HOT ROD's own Kimson Ekman, which Sirman won with a final average of 15.80 to Ekman's 15.86. Sirman's low-buck approach included a 50-gallon fuel tank from a tractor-trailer bolted to the rear of the frame and intake plumbing made from 4-inch PVC piping covered with an old, rusty mailbox.



There's no way we can describe the sight and sound of Bryan Prather's blown 1969 Corvette wailing on the road past an airplane graveyard. His homebuilt hot rod didn't seem to impress the armed guards at the military base, though, and they politely suggested we take our stroked small block-powered Chevy off government property.



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The route took us through a desert so picture perfect you expected any minute to see Wile E. Coyote chasing the *beep-beep* of the cartoon Road Runner around the cacti. We avoided falling rocks, but did hit some rain, which isn't exactly the best thing for cars with questionable windshield wipers on minimally treaded tires. Bill Fowler told us the trick to it was to find the exact right speed where the rain "slid right off." For his 1987 Mustang, he said it was about 10 mph more than the posted limit. Sure, Bill, tell it to the cops. Fowler killed the transmission in the ex-CHP car at the second track, putting him out of competition. "After loading my broken car, we headed to California and caught up with Lutz. His Pro Mod made the trip and we didn't!"

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Day 2's Tucson Dragway is not the first racetrack to use that name, and just a few miles from the modern facility are the overgrown remains of "Old" Tucson Dragway. Announcer Brian Lohnes refused to announce unless we snuck over the gate and scoped out the crumbling lanes.



NONSTICK

Need to clean the rubber off the fenders of a car you weren't supposed to take racing? Take a tip from a Dodge SRT engineer and spray some Pam on the wheelwells before your burnout.



It's easy to get jaded when you see fast cars all day long, so it's pretty fun to see what happens when a drag-racing neophyte gets a taste of horsepower. Fox 10 News from Phoenix came out to Wild Horse Pass Motorsports Park for the second day of Drag Weekend racing, and reporter Cory McCloskey put on a helmet and climbed in the passenger seat of Jeff Bomyea's 1968 Camaro for a high-9-second pass at 109 mph—off the gas. The Fox team enjoyed their drag time so much they decided to take the news van down the track. The fully loaded news van ran a smoking-slow 32.05 at 35.33 mph. Watch out, Jeff Lutz. "Sheesh, how do they cover the news?" Lohnes asked. "Seems like it would be over by the time they got there."





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WESTWARD HO(RSEPOWER)



The route from Phoenix to Fontana was 345 miles, and 344 of them were on long, straight Interstate 10. Things got good right away as we paced Jeff Lutz and Scott Murray in the long-nosed Pro Mod Camaro. Lutz and Murray were laughing and shouting at each other inside the car, but the real show was outside, as Arizona commuters seemed torn between fury at his slow-lane pace of about 58 mph and delight at the unusual addition to their afternoon drive. The traffic leaving Phoenix is pretty stout, and the turbo-muffled boom of Lutz's 525ci Pat Musi big-block bounced around between lowered Civics and irate Prius hybrids. Lutz ended up with the overall win at the very first HOT ROD Drag Weekend. His final run gave him weekend averages of 6.4767 and 211.39 mph. "I hate to fail," Lutz told us. "I would rather lose than fail to finish, so this is a redemption."



The only thing I remember about Drag Weekend was getting to meet Jeff Lutz and sit in his car. Everything else is a blur."

— Dodge SRT engineer Paul Rodriguez

Every stop was full of car talk, and at a gas station near the General Patton Museum in Indio, California, we saw a lettered-up white Datsun pull in to a pump ahead of Troy Clark's 1930 Ford. The driver, Jason Winget, was driving around the entire United States in his 1970 Nissan Fairlady Z.



One bit of news marred the last leg of our journey. Dave Schroeder and John Ens, the Fightin' Corvette Canadians who changed a cylinder head on the side of the highway the night before, finally called it quits when an oil leak became a major danger on the headers.



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Ben Berniklau owns a VW shop. He and his buddy, Cory Taffola, showed up with two VW bugs on a double-decker trailer. "What a pain to put a fullsize bug on top, and way worse to get off," he said about the twin transport. The bug went on to claim a 12.58 average. "We got our butts kicked in the bracket race by the V8 cars, which is pretty standard, but when the other guys were loading up their trailers to head out, I just aired up my tires, opened the sun-roof, and jammed home with a smile on my face—best time racing I ever had."

“The route through Tucson went a block away from my mom’s house. So I stopped by to visit. That was neat!”
— Jim Forbes



Brandon Gant was one of three Dodge Darts in competition. "Everything was going great until we were on the road," he told us. "I heard a big slam and there were my slicks falling off the roof and following me down the highway. That was when I realized that I was officially on an adventure."



In 2004, HOT ROD ran the Pump Gas Drags, which is sort of where all this craziness came from. Dan Geis remembers, because his car was there, only the sweet 1964 Nova wasn't his car yet. It was built and raced by Jim Henn. Henn died in an off-road crash in 2007, but we think he'd be proud to see his machine still kicking butt at street legal drags. "The car was conceived and built to commute to work during the week," Geis told us, "but to also lay down 9-second passes at the track on the weekend, so split-personality events like this are a natural fit. No mini-trailer, no tire changes, no re-tuning/adding race gas. Just turn off the freeway, top-off the tank, empty out the trunk, air down the tires, suit up, and head to the lanes." □

It's a good thing Thompson is a firefighter, 'cause the 'Bee is hot, with a patinaed orange paint job and a Six-Pack 413 wedge under the lift-off hood. Did we mention it's a stick?

| NAME | CAR | CLASS | AVERAGE E.T. | AVERAGE MPH |
|------------------------------|-------------------------------|--|--------------|-------------|
| JEFF LUTZ WINNER | 1969 Chevrolet Camaro | Unlimited | 6.477 | 211.39 |
| BRYAN PRATHER | 1969 Chevrolet Corvette | Unlimited | 9.398 | 142.773 |
| JOE BARRY | 1956 Chevrolet SportsCoupe | Unlimited | DNF | DNF |
| DAVE SCHROEDER | 1966 Chevrolet Corvette | Unlimited | DNF | DNF |
| FLOYD AZLIN WINNER | 2014 SRT Viper | Modified Big-Block Naturally Aspirated | 12.180 | 124.557 |
| ROB PARSONS WINNER | 1993 Ford F-150 Lightning | Modified Small-Block Power Adder | 8.880 | 152.473 |
| KEN RIDDLE | 1969 Dodge Dart | Modified Small-Block Power Adder | 11.369 | 117.873 |
| JEFF BOMYEA WINNER | 1968 Chevrolet Camaro | Super Street Big-Block Power Adder | 7.797 | 181.003 |
| DAN GEIS WINNER | 1964 Chevrolet Nova | Super Street Big-Block Power Adder | 9.683 | 140.41 |
| BRIAN ROCK WINNER | 1965 Pontiac GTO | Super Street Big-Block Naturally Aspirated | 10.305 | 130.27 |
| STEVEN GRAY | 1967 Chevrolet Camaro | Super Street Big-Block Naturally Aspirated | 14.408 | 95.103 |
| JOHN GAY | 1970 Plymouth Barracuda | Super Street Big-Block Naturally Aspirated | DNF | DNF |
| WILLIAM FOWLER | 1987 Ford Mustang | Super Street Big-Block Naturally Aspirated | DNF | DNF |
| ROSS GAULT | 1969 Chevrolet Camaro | Super Street Big-Block Naturally Aspirated | DNF | DNF |
| TODD PETERSON WINNER | 1992 GMC Typhoon | Super Street Small-Block Power Adder | 13.212 | 97.453 |
| STEVEN FORRESTER | 1993 Ford Mustang | Super Street Small-Block Power Adder | DNF | DNF |
| KEVIN STUDAKER WINNER | 1972 Chevrolet Concours Wagon | Super Street Small-Block Naturally Aspirated | 10.384 | 129.143 |
| WILLIAM FREDENBURG | 1968 Ford Mustang | Super Street Small-Block Naturally Aspirated | 11.03 | 122.323 |
| JOHN SYLLIAASEN | 1970 Chevrolet Camaro | Super Street Small-Block Naturally Aspirated | 12.403 | 110.1 |
| JONATHAN GRAY | 2012 Dodge Challenger | Super Street Small-Block Naturally Aspirated | 14.245 | 99.283 |
| FRED SIRMAN | 1964 Ford F-100 | Super Street Small-Block Naturally Aspirated | 15.801 | 85.84 |
| JAMES FORBES WINNER | 1962 Chevrolet Chevy II | Gasser | 10.813 | 122.963 |
| TROY CLARK WINNER | 1930 Ford Model A | Hot Rod | 8.796 | 157.35 |
| JIM WILDER | 2015 Dodge Challenger | Street Machine Eliminator | 10.862 | 127.997 |
| BARRY BERGER | 2012 Nissan GT-R | Street Machine Eliminator | 10.962 | 131.427 |
| STUART BARADA | 1968 Chevrolet Camaro | Street Machine Eliminator | 11.465 | 116.987 |
| BRANDAN GANT WINNER | 1973 Dodge Dart | Street Machine Eliminator | 11.850 | 106.89 |
| DREW MCKINLEY | 2000 Chevrolet Camaro | Street Machine Eliminator | 12.095 | 115.073 |
| TRENT PETERSON | 1973 Plymouth GTX | Street Machine Eliminator | 12.435 | 107.16 |
| KARL HARDESTY | 1963 Ford F-100 | Street Machine Eliminator | 12.521 | 106.67 |
| BEN BERNIKLAU | 1967 Volkswagen Bug | Street Machine Eliminator | 12.584 | 105.313 |
| PAUL BALDACCHINO | 1964 Ford Falcon Wagon | Street Machine Eliminator | 13.05 | 104.653 |
| COREY TAFFOLA | 1967 Volkswagen Bug | Street Machine Eliminator | 13.732 | 96.3 |
| CHASE RIDDLE | 1974 Dodge Power Wagon | Street Machine Eliminator | 13.789 | 99.49 |
| BOB SAUZEK | 1965 Ford Fairlane | Street Machine Eliminator | 14.119 | 95.773 |
| CHRISTOPHER THOMPSON | 1969 Dodge Super Bee | Street Machine Eliminator | 14.695 | 86.147 |
| KIMSON EKMAN | 1966 Buick Wildcat | Street Machine Eliminator | 15.865 | 84.957 |
| AGUSTIN JIMENEZ | 2003 Ford F-350 | Street Machine Eliminator | DNF | DNF |
| DAVID FREIBURGER | 1970 Plymouth Duster | Street Machine Eliminator | DNF | DNF |

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LOT 63098/61899/60497/62399
63095/63096/63097/93888 shown

- 1000 lb. capacity

\$8⁹⁹ comp at \$19.97

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SAVE \$90

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WOW SUPER COUPON

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LOT 62541/60568/91753 shown

\$12⁹⁹ comp at \$49.99

45318160

SAVE 74%

\$58⁹⁹ comp at \$999

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GRUDGE MATCH GLORY

We Put the **2016 Chevrolet Camaro** on the Dyno, on Track, and on the Road—and it's Unbeatable

► The first conversation we had with Jeff Lutz came after he blew the tires away on his first run. “Did you floor it off the line?” he asked as he came back into staging. “Oh, god, no,” we answered. “Put the throttle down gently. Like you’re handing a baby to someone.” Then he took our advice and beat us. The jerk.

We didn’t know how good the 2016 Chevy Camaro was when we invited professional drag racer Lutz to help us dragstrip test it at Wild Horse Pass Motorsports Park in Chandler, Arizona. In fact, we were worried that Lutz wouldn’t have a good time. After all, he builds drag cars for a living and spends most of the year at racetracks, either supporting customers or behind the wheel of his own 2,500hp race car. We figured he’d be bored with a 455hp SS. That was underestimating both Lutz’s love of racing and the capabilities of the sixth-gen Camaro.

The Camaro started impressing us long before we got it on track. We picked up two 2016 SS cars in Dallas and had a day to get them to Wild Horse near Phoenix in time to race Lutz, and from there we had to drop them off in Los Angeles. You can learn a lot about a car in 1,500 miles.

 Elana Scherr and Brandon Gillogly

 Brandon Gillogly and Elana Scherr



THE CAR

Walking up to the 2016 model is like playing one of those “spot the difference” memory games. If there isn’t a fifth-gen parked nearby, you might be forgiven for thinking that not much has changed. The new car keeps the wide-hipped, muscle-car profile, with the same love-it-or-hate-it high cowl and low roofline. The grille shapes and patterns have changed, but they are in familiar places. The new hood moves the highlights of the center bulge to side-placed vents, and in the back, the taillights have a jaunty little

angle to them. The Camaro has always been a good-looking machine, so we understand the reluctance to do more than the barest nip/tuck. The problem with the subtle redesign is that potential customers might miss how radical the 2016 Camaro’s changes really are.

The sixth-gen is an entirely different machine. The 2016 has all-new underpinnings, and that freed up the engineers to make the car lighter and better-handling. Much of the floor stampings are similar to the Cadillac ATS coupe, which shares the Camaro’s Alpha platform, but the Camaro isn’t a Cadillac with a sporty body. It’s stiffer and lighter than the ATS, with an increased track width, a longer wheelbase, and unique

[We took our SS to Addiction Motorsports in Canoga Park, California, and made a couple of dyno runs. As the engine warmed up, we got our best number, 405 hp and 405 lb-ft of torque, suggesting that the LTI’s new tri-Y exhaust manifolds are doing a good job of scavenging exhaust, with torque output remaining above 350 lb-ft from the dyno pull’s start at 1,800 rpm all the way to 6,000 rpm. Based on the LTI’s SAE-proven 455hp output, that’s only an 11 percent drivetrain loss—impressive for a car equipped with independent rear suspension. The LTI and six-speed put as much horsepower to the ground as the LTI Stingray we tested previously and also as much as a 6.4L Scat Pack Charger.

suspension geometry.

The weight is what everyone has been talking about. The Camaro SS shed more than 200 pounds compared to the 2015 car—although our heavily optioned test car put most of that back on, and our frequent Texas BBQ stops probably added another hundy to the total. That doesn’t matter, though, because it’s not the car’s weight loss so much as the remaining weight placement that makes the 2016 SS so much better than its predecessors. Chevrolet went techy in the material choices, matching each part of the chassis and body to exactly the right kind of steel to add strength and rigidity with less mass. Cut a piece out of the windshield pillars and it won’t be the same metal making up the doorjamb. Bolt lengths were measured and trimmed so there isn’t a single fastener adding more ounces than necessary. The result is noticeable from the first time you take a corner. We put more road miles on our two test cars than most customers

[We recorded highway fuel economy in the mid- to high-20s, balanced by enthusiastic acceleration and ample use of rev-matching downshifts around town that dragged our average down to a respectable 23 mpg over the course of our test.





[The higher-trim-level cars come with mood lighting and a lot more leather-wrapped panels that make the interior much more upscale. In our brief time with the Apple CarPlay interface, we found the navigation to work well with voice-to-text address inputs, and the streaming audio from Pandora was seamless, but only for Brandon Gillogly's phone. Elana Scherr's phone wouldn't work at all, although Bluetooth was fine. We assume it has to do with the quality of non-Apple USB cables.]



[It's not a HOT ROD road trip without a food recommendation. We had some good eats along the way, but the winner was El Metate Tamale Factory in Gallup, New Mexico.]



[One of the best stops on our trip was at the Unser Racing Museum in Albuquerque, New Mexico. It's a huge collection of cars and bikes spanning the Unser family's involvement with motorsports from the early Pikes Peak days to NASCAR and Indy racing. Our enthusiastic, last-minute, offramp usage when we saw the sign would have made Bobby Unser proud.]

will in their first year of ownership, and we found the car was responsive on quick, curvy roads, but still comfortable and solid on long highway stretches—and Texas is all about long highway stretches.

Chevy offers a turbo-four, a six-cylinder, and the one we care about, the direct-injected LT1 6.2L V8. The LT1 in the Camaro shares most of its design with the Corvette Stingray, the most noticeable differences being the oil pan, tri-Y headers, and supposedly, 5 less horses. The Corvette engine is rated at 460, the Camaro at 455, but based on our dyno test of the manual car—where it made an impressive 405.2 hp and 405.4 lb-ft at the wheels on its best run—we think the ponycar might be packing just as much as its sportscar brother. It's easy to get jaded about horsepower numbers, but when we stopped to check out Stewarts Petrified Woods in Holbrook, Ari-

zona, the clerk asked us the power, and then said, "Wow, what's top speed? 300 mph?" He was serious.

We had two cars for our drive: a stripped-down 1SS with the Tremec TR6060 six-speed (MSRP \$37,295) and a lux 2SS with sunroof, magnetic ride control shocks, speed-enhancing black stripes, and the eight-speed 8L90 Hydra-Matic (MSRP \$47,750). Both cars offered the dual-mode (NPP code) exhaust, something that made blipping the throttle at each other on the road-trip portion of the drive that much more entertaining. In cars equipped with the NPP exhaust, a huge transverse muffler is divided in two internally for each bank of the engine leading out to four exhaust tips. A butterfly valve can either let the exhaust flow through unobstructed or detour through the muffler. Tour mode lets the LT1 come to life at full volume on startup—so you can

impress folks in the grocery-store parking lot or roadside fossil stand—then the valve closes for quiet cruising. In Sport and Track mode, it's open all the time. Snow/Ice mode leaves it closed all the time. We did not use Snow/Ice mode, not even when we were driving through snow and ice. A little HOT ROD advice here: never press a button that gives you less horsepower.

Speaking of buttons, the Camaro has really stepped up the interior options. The dash design features a step-down that breaks up the long, dust-collecting expanse of modern safety requirements. The generous 8-inch center screen, standard in all 2016 Camaros, is tilted downward slightly to reduce glare. Those who are averse to smudged touchscreens can rely on the buttons on the steering wheel and below the screen. Also good for the tactile driver are the textured silver bezels surrounding the air vents that rotate to control temperature and fan speed. You don't realize how nice it is to be able to change settings without having to take your eyes off the road until you're frantically turning the heat up during a freak snowstorm on an Arizona mountain road because your fellow editor nabbed the 2SS with its heated seats and steering wheel.

Even without luxurious bum-warming, the Camaro's seats are the most comfortable of any new car we've been in. There's a huge range of travel that accommodated both the shortest and tallest drivers on the HOT ROD staff. In the LT-package car, we had cloth seats and a lot of plastic, although nicer plastic than in previous generations. The upscale interior in the 2SS is the best a Camaro cockpit has looked since the houndstooth seats of the late-1960s, with soft, leather-wrapped panels and customizable mood lighting that we made fun of, but then played with for an hour and half. Not only



[You'll hear a lot about weight savings, and the 2016 is lighter than the 2015, but at 3,728 pounds for a fully loaded 2SS automatic, and 3,617 for a stripped-down six-speed, it's not exactly a featherweight.



[SS six-speed cars wear a red and silver plaque with the gear pattern.



[The transmission cooler is on the same plane as the road surface. The lip on the leading edge of the transmission cooler opening causes a low-pressure area to help draw air through.



[Because the Alpha platform is narrower, Camaro engineers split the engine cooling between three radiators. One is mounted in the traditional location and uses an 850-watt electric fan. Two outboard radiators are canted inboard and fed high-pressure air from the outer edges of the center lower grille opening.



are the seats comfortable but the entire driving position is excellent. The flat-bottomed steering wheel gives you plenty of legroom, and the shifter in the manual car is a satisfying snick-snick to the chosen gear. We especially noticed the well-balanced pedals; there was none of that heavy throttle and overly touchy stopper mismatch. In the three-pedal car, the clutch balances perfectly with the brake and gas. It's a small thing, but makes the driving experience that much better.

That's not to say everything about the new design is perfect. We wanted a smaller

Camaro, and GM gave us one. You can't lose weight and inches without sacrificing some cabin space. The rear seats are about as useful as the hollow benches in a F.A.S.T.-class car. Chevy should have saved some money and just gone with jump seats like in a 1990s pickup truck. At least then one passenger in the back could have had legroom. Even in the front passenger seat, space is at a minimum, as the Camaro transmission tunnel placement favors the driver. Behind the wheel, there's plenty of space, so if you consider it a single-seater, then it's huge.

The ongoing complaint about visibility is still valid thanks to that low roofline, but complaining about it takes longer than simply checking your mirrors. We had one car with blind-spot warnings and one without, and both made it 3,000 miles with no collision damage. Rearward visibility is compromised by the tall decklid and spoiler when backing up, making the rear-facing camera a necessity. They'll be mandatory on all light vehicles sold in North America by 2018, anyway, so just get ahead of the curve.

THE RACE

Small quibbles aside, we came into our track test feeling pretty fond of the new Camaro, and we had every confidence that it would make its promised press release e.t.'s of 12.50 for the six-speed manual and 12.30 for the automatic. In fact, with our hot-shoe driver and mineshaft desert air, we thought we just might be able to beat Chevy's drag numbers. Our track preparation for both cars was the same: half a tank of gas and cleaning all the empty coffee cups and Red Bull cans from our 16-hour commute out of the consoles and cupholders. Tires were the stock Eagle F1 Asymmetric 3 245/40ZR20 (front) and 275/35ZR20 (rear) rubber run at street pressures on 20-inch aluminum wheels.

Wild Horse Pass is an excellent track. We had careful prep on the starting line, but it was still what we'd consider a "street-car" preparation—sticky for the launch and clean down the rest of the quarter-mile. The perfect weather and fantastic surface deserve a nod, but most of the credit for the incredible times we saw belongs to the Camaro. The car is an absolute darling on a dragstrip.

Once you get the hang of the baby-passing launch, both the manual and the auto track straight and true, pulling the whole way. We traded off best runs with Lutz in the 2SS, hovering in the 12.30 mark from the get-go until he pulled ahead with a 12.28 at 114.38 mph. Then we got a 12.23. Then he got a 12.21. Then the track officials pointed out that between the two cars we'd made more than 80 passes, and timeslips were floating around the start line like dollar bills after a bank heist. Translation: our track rental was up. How does a day go so fast 12 seconds at a time? The end result was a best e.t. for the automatic of 12.21 at 114.93. The manual put down a 12.40 at 115.30. On a few runs, we saw top speeds of almost 116, and one particularly good launch netted a 60-foot time of 1.87—most of the fast-pass 60-foots were in the 1.9 range. Our conclusion? The car is way quicker than its advertised e.t.'s and could be even quicker than any of our e.t.'s, given a sticky track and a patient throttle application.

We made our best pass in a customized version of Track mode, with the suspension in the softer Touring setting—something that could only be changed in the magnetic ride control (MRC)-equipped car. Lutz went full Track and made the quickest pass of the day with the stiffer settings. New car modes can be trickier than they seem, much of the changes dependent on what the engineers consider a "track." For example, in a Dodge Hellcat, "Track" mode uses more anti-slip than "Sport" mode to get you out of road-course corners with less tire spin. In the Camaro's sophisticated brother, the Z06, there are five different variations of more or less digital babysitting, with the top setting being minimal interference—right before

you turn it all off. We call that mode, "You're on your own, kid."

We checked in with Camaro's lead development engineer, Aaron Link, to see if there were any behind-the-scenes details of mode changes that we were missing, but it turns out the Camaro is pretty straightforward. The mode changes do not affect the traction control, so any performance mode can be made into "You're on your own, kid," simply by holding down the traction-control (TC) button on the console. There is a secret "relaxed" mode that gives you some but not all of the traction control. You can get that from a double tap on the TC button. It might be good for cautious road-course use, but for drag racing, you want it all off.

You'd expect Track mode to be the most aggressive, and it is, with the stiffest suspension, tighter steering response—slightly too touchy for the street, in our opinion—and harder, quicker shifts. The exhaust note is louder and it offers launch control. The one surprise is that the throttle response in Track mode is, not slowed down exactly, but made more subtle. "It's a slower ramp in the Track mode," Link says. "A more elastic throttle, to offer better control on a road course." This less aggressive throttle response might have had the added benefit of assisting with the launch at the dragstrip. The hardest part about getting any foot-braked, street-tire car down a dragstrip is the delicate application of the gas pedal.

Much as it pained us, the automatic car is quickest if you let it make the shifts for you. The paddles are slow to respond, and there's just no way to beat the machine if you flip through the gears by hand. The six-speed car is easy to launch and a pleasure to shift. Its slower times have more to do with gearing



than shifting. Although its 3.73 rear gears are lower than the auto's 2.77, the transmission ratios end up giving the automatic a definite starting-line advantage with a final ratio of 4.56. Yeah, that's a sweet number for a car that can cruise 90 mph on the highway at 1,800 rpm. Despite that, the manual car is much more fun on the street, and that's the option we'd check off on a dealer order form if we were in the market for a new Camaro.

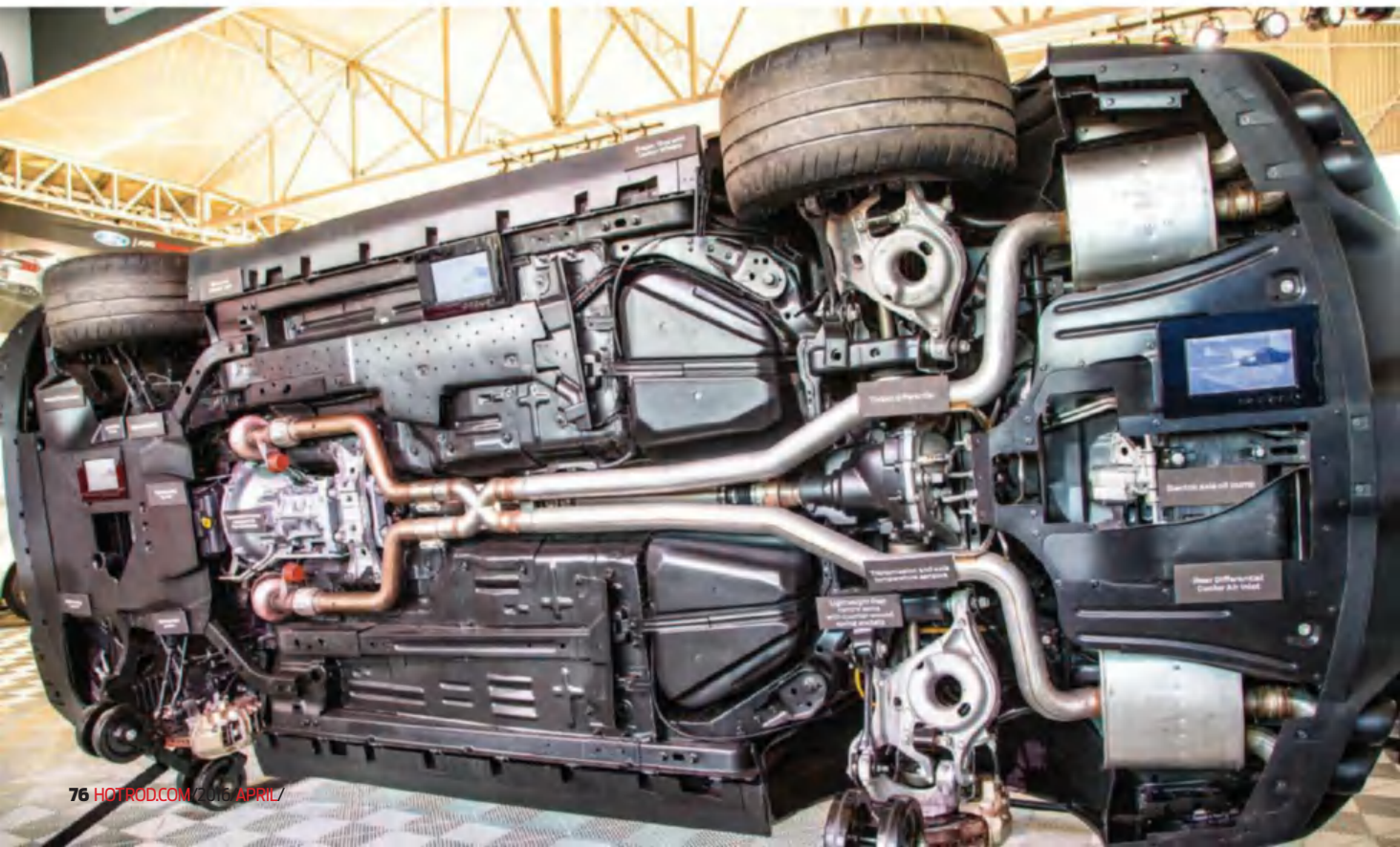
So, new-car shoppers, should you buy the sixth-gen Camaro? A resounding yes. There's nothing about the fifth-gen that isn't a thousand times better in the new car. Hell, we just ran the same e.t. numbers in the SS that people were barely making in the fifth-gen ZL1. Was Lutz bored? "It's been a long time since I've been at a track just having fun, not wrenching on anything," he said. "It's amazing you can just go out and buy something that runs like this—just fast hot laps, no problems." Can you imagine what the performance package cars are going to offer us? Watch out Hellcat, and Mustang who? □





15 Things You Don't Know About the *Shelby Mustang* *GT350* and GT350R

David Kennedy
Wes Allison



► The first thing you have to know about the Ford Mustang Shelby GT350 and GT350R is that they're not just Mustangs run through the performance-parts bin. Like Ford's successful 2010–2014 F-150 Raptor program (an off-road truck based on the F-150 with desert-racing-bred shocks, tires, seats, and unique bodywork), the 2015 Mustang GT350 and GT350R are practically all-new cars simply based on the 2015 Mustang GT architecture.

According to the Chief Engineer of Ford Performance Jamal Hameedi, the GT350 and GT350R are a collection of “bespoke parts specifically combined to make a balanced vehicle.” Hameedi would know, he was—by no coincidence—the driving force behind Ford's extremely successful F-150 Raptor program.

Some readers may be disappointed to learn it'll be nearly impossible to build a 2015 Ford Mustang GT into a GT350 (or the more extreme GT350R) due to the level of unique parts. It certainly won't be cost effective to do so. The good news, however, is that once you add up all of the unique features of the GT350 you realize what a performance value these cars are, even with a starting price of \$49,995. Need more convincing before you trade in your Mustang GT for a GT350? Here are 15 more things we learned from Hameedi and his team about the GT350 and GT350R before Ford let anybody drive one.

01 The GT350 and GT350R use a wider front clip than the Mustang GT, and it's completely unique from the A-pillar forward.

02 The front 305mm wide tires are attached to unique GT350/GT350R aluminum steering knuckles. The base Mustang and GT cars use cast-iron steering knuckles.

03 Ford fit stiffer front wheel bearings and unique radial-mounted brake calipers that allow for a stiffer mounting than traditional cross bolts to these unique steering knuckles. The stiffer front wheel bearings are said to reduce caliper knockback, a condition where deflection in the wheel bearings allow the brake rotors to push the brake pads into the caliper pistons and back into their bores, creating a “knockback.” This knockback creates an unpredictable and unstable brake pedal feel.

04 Because of the unique frontend and wider front track width, the tire-scrub radius of the GT350 and GT350R have been optimized to be just outside of the front tire's static centerline. This was done to target the functional centerline of the tire—not the static centerline of the tire—when the car experiences extreme cornering loads.

05 Jamal Hameedi, chief engineer of Ford Performance said, “The [GT350] is all about balanced handling and performance” and that “more engineers have worked on this car than any Mustang in history.” Hameedi went on to say, “We've gone further than many engineers thought we would, or could.”

06 The Mustang GT350 and GT350R's flat-plane crank 535hp 5.2L V8 engine is lighter than the Ferrari 458's flat-plane-crank 4.5L V8 engine.

07 Ford Performance developed the GT350 over a three-year period.

08 When asked if the Ford F-150 Raptor's success paved the way for Ford Performance to create the GT350, Hameedi said, “Because the Raptor was a success, Ford let the leash out on this car—to get parts like the flat-plane crank, the wheels, and the brakes. Those parts are from off the reservation. All of the gold [in this car] comes from off the reservation.”

09 Hameedi reports that Ford couldn't have reached its specific power output goals for the GT350 without the flat-plane crank: a naturally aspirated 100 hp per liter.

10 One of the benefits of the flat-plane crank is that it improves windage and oil control in the engine's crankcase. The way Ford does it, the 5.2L flat-plane engine “breathes” bay-to-bay (side-to-side) instead of from the front of the engine to the rear—the way a traditional cross-plane crank V8 engine does.

11 By spraying the bottoms of the GT350/GT350R's 5.2L's pistons with oil jets from the main oil galley, Ford engineers were able to create better knock control. This allows 2 degrees more spark advance from the 12:1 compression 5.2L without detonation.

12 The 5.2L engine was designed for 93-octane fuel, but will run on 87 octane with only a 15hp decrease in peak power.

13 The GT350 has been to more track days than any Mustang in history. “We've probably got triple the number of track days in it then we had with the GT500,” Hameedi said.

14 The benchmark for the GT350 was originally the Porsche 911 Carrera S, then Ford Performance upped the ante by targeting the Porsche GT3.

15 When asked whether drag racing or road-racing development led to a better daily driving car, Hameedi conceded that “if you have tunnel vision for either one you won't have a great daily driver,” but if he had to choose he said a road race car could still be good on the street. □

FORD SHELBY GT350/ GT350R MUSTANG SPECS

FINAL ASSEMBLY LOCATION: FLAT ROCK, MICHIGAN

| DRIVETRAIN | |
|------------------------------------|---|
| LAYOUT | Rear-wheel drive with Torsen limited-slip differential and 3.73:1 gears |
| TRANSMISSION | Tremec TR-3160 six-speed manual |
| GEAR RATIOS | |
| 1ST | 3.253:1 |
| 2ND | 2.233:1 |
| 3RD | 1.611:1 |
| 4TH | 1.243:1 |
| 5TH | 1.00:1 |
| 6TH | 0.629:1 |
| BODY | |
| CONSTRUCTION | Unitized welded steel body, aluminum hood, front fenders and front bumper beam, carbon-fiber grille opening reinforcement |
| ENGINE | |
| 5.2L FLAT-PLANE CRANK V8 | |
| CONFIGURATION | Aluminum block and heads, 90-degree V8 |
| INTAKE MANIFOLD | Composite shell with scroll design and motion-control valves |
| EXHAUST MANIFOLD | Tubular stainless steel |
| VALVETRAIN | DOHC, four valves per cylinder, twin independent variable camshaft timing |
| VALVE DIAMETER/LIFT | Intake, 38.3mm/14 mm; exhaust, 32.5mm/14 mm |
| PISTONS | Forged aluminum |
| CONNECTING RODS | Forged micro-alloyed steel |
| IGNITION | Coil-on-plug |
| BORE X STROKE | 94.0 x 93.0mm |
| DISPLACEMENT | 5,163 cc |
| COMPRESSION RATIO | 12.0:1 |
| HORSEPOWER | 526 hp at 7,500 rpm |
| TORQUE | 429 lb-ft at 4,750 rpm |
| FUEL CAPACITY | 16 gallons |
| FUEL DELIVERY | Port fuel injection with twin high-flow pumps |
| OIL CAPACITY | 10 quarts 5W-50 with filter |
| EPA-ESTIMATED FUEL-ECONOMY RATINGS | 14-mpg city, 21-mpg highway |
| BRAKES | |
| TYPE | Four-wheel power discs with four-sensor, four-channel antilock braking system and AdvanceTrac electronic stability control |
| FRONT | 15.5x1.4-inch aluminum hat, floating-type vented and cross-drilled discs |
| CALIPER | Brembo six-piston fixed aluminum calipers |
| REAR | 12.6x1.0-inch vented and cross-drilled discs, drum-in-hat parking brake |
| CALIPERS | Four-piston fixed aluminum |
| WHEELS AND TIRES | |
| GT350 | 19x10.5-inch aluminum alloy, Michelin Pilot Super Sport 295/35ZR19, front; 19x11.0-inch aluminum alloy, Michelin Pilot Super Sport 305/35ZR19, rear |
| GT350 TACK PACK | 19x10.5-inch aluminum alloy, Michelin Pilot Super Sport 295/35ZR19, front; 19x11.0-inch aluminum alloy, Michelin Pilot Super Sport 305/35ZR19, rear |
| GT350R | 19x11.0-inch carbon-fiber, Michelin Pilot Sport Cup 2 305/30ZR19, front; 19x11.5-inch carbon-fiber, Michelin Pilot Sport Cup 2 315/30ZR19, rear |

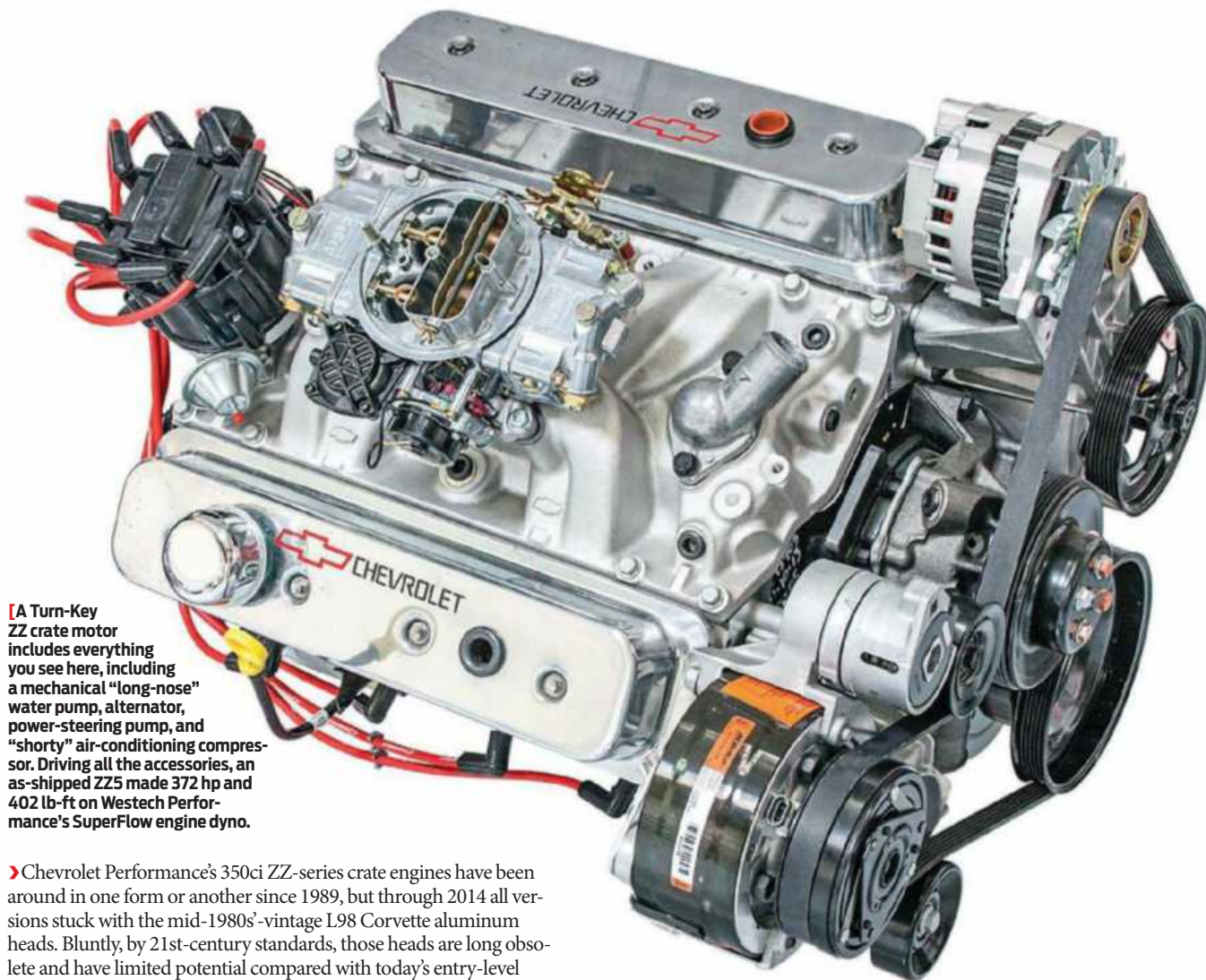
HOW TO TELL A GT350 FROM A GT350R

The rear wing and wheel differences are hard to pick up on, so look for the red Cobra badge in the grille and the missing back seat to tell if you're looking at a GT350R.

FLOGGING CHEVY'S ZZ5

With Its Fast Burn Heads, the ZZ5 Marked a Significant Upgrade From Previous ZZ-Series Crate Motors. How Does It Respond to Typical Hot Rod Bolt-Ons?

✍️ 📷 Marlan Davis



[A Turn-Key ZZ crate motor includes everything you see here, including a mechanical “long-nose” water pump, alternator, power-steering pump, and “shorty” air-conditioning compressor. Driving all the accessories, an as-shipped ZZ5 made 372 hp and 402 lb-ft on Westech Performance’s SuperFlow engine dyno.

➤ Chevrolet Performance’s 350ci ZZ-series crate engines have been around in one form or another since 1989, but through 2014 all versions stuck with the mid-1980s’-vintage L98 Corvette aluminum heads. Bluntly, by 21st-century standards, those heads are long obsolete and have limited potential compared with today’s entry-level aftermarket offerings. Recognizing this, starting with the ZZ5 in late 2014, GM upgraded the package to its modern Third Design Fast Burn heads that meld Vortec and Gen II LT4 technology to produce a fairly decent cylinder head.

In our opinion, that’s a crucial improvement, because in theory it should let this crate motor better utilize the potential of modern aftermarket bolt-ons. Realistically, most customers aren’t going to run out and install new heads on a brand-new complete engine—that defeats the whole purpose of a crate motor. On the other hand, for many it’s not a deal-breaker to install an intake, carb, ignition, or even

a better cam. So that’s exactly what we did: Get a complete Turn-Key ZZ5 engine assembly shipped to our go-to West Coast dyno facility—Westech Performance in Mira Loma, California—then evaluate a bunch of typical aftermarket bolt-ons, and see how the mill responds. By the time we were done, GM had already introduced the ZZ6, but as you’ll see, most of what we found on the ZZ5 is directly applicable to the direction GM is taking on the latest version.

BASLINE RUNS

GM sold the ZZ5 as a base motor including the intake manifold and HEI distributor, as well as a complete Turn-Key assembly complete with everything needed to get the engine up and running in a car—less exhaust system. That included a complete front serpentine-belt-drive system with accessories. We've always wanted to see how much a full set of accessories actually hurts torque and power output, so we started with the complete Turn-Key package, including alternator, power-steering pump, and air-conditioning compressor. The power-steering pressure hose was



[After the initial baseline test with all accessories spinning, Westech removed them and installed its standard dyno Meziere electric water pump. Max output jumped to 385 hp and 411 lb-ft.]

ZZ5 350CI BASELINE RUNS

| TEST DESCRIPTION | UNIT OF MEASURE | OUTPUT | | CHANGE* | |
|---|-----------------|---------------|-------|---------|------|
| | | MAX @ RPM | AVG. | MAX | AVG. |
| As-shipped Turn-Key configuration with serpentine-driven alternator, power-steering pump, A/C compressor, and mechanical water pump | Torque (Lb-Ft) | 402.4 @ 4,000 | 375.3 | — | — |
| | Power (HP) | 371.9 @ 5,600 | 302.3 | — | — |
| Remove accessories and mechanical water pump, install Meziere electric water pump | Torque (Lb-Ft) | 410.9 @ 4,000 | 384.6 | +8.5 | +9.3 |
| | Power (HP) | 384.9 @ 5,700 | 310.3 | +13.0 | +8.0 |

*Change over previous test. Test sweep: 2,500–6,000 rpm.

looped back to the return side, and the air-conditioning compressor was never engaged. The secondaries on the Turn-Key engine's GM-supplied 670-cfm vacuum-secondary Holley carburetor were wired full open. On test day, the weather was cold and damp; the secondaries were jetted up one number richer—from the as-shipped 74s to No. 75s. In this trim, the motor made 371.9 hp and 402.4 lb-ft of torque.

Next, Westech technician Steve Brulé removed the front drives as well as the stock GM long-nose mechanical water pump and installed Westech's standard dyno rig, a Meziere electric

water pump. The new baseline (which would be used for all subsequent tests) jumped to 410.9 lb-ft of torque and 384.9 hp. That was up 8.5 lb-ft and 13 hp from the mechanical water-pump/full accessory-drive configuration. Old-school V-belt systems are said to be even more inefficient. On the other hand, even a minimalist real-world system still needs to drive the alternator and (usually) a mechanical water pump, so the real-world output would probably be down at least 5–7 hp from these values.

BASLINE RUNS



HOW WE TESTED

Westech ran the engine at varying rpm and loads and performed some preliminary timing and calibration. Using Union 76 California 91-octane unleaded gas, multiple 300-rpm/second sweep-runs were then conducted for each test combination. The numbers reported in this article represent the average of the two best back-to-back runs for each test combination, as corrected to standard atmospheric conditions using the SAE J607 correction factor. For the exhaust system, we used Westech's standard dyno headers with 1¾-inch primaries dumping into 3-inch collectors with 18-inch extensions. The initial runs quickly established that the engine liked 35 degrees total ignition advance, rather than the 32 degrees recommended by GM. Jetting was varied as needed to obtain the best overall power for the conditions. Coolant temperature was stabilized to 135 degrees F at the beginning of each run.

DUAL-PLANE VS. SINGLE-PLANE

The early ZZ3 through ZZ2 engines used a Holley-flanged, high-rise, Z28-style, dual-plane intake manifold. The ZZ3 through ZZ4 engines went to a low-profile intake machined for both Holley and Quadrajet carbs that cleared the hood on third-generation Camaros. On the ZZ5, GM returned to a dual-plane, high-rise, Holley-flange intake, but the all-new design has taller, Vortec-style intake runners to match the Fast Burn head's ports and Vortec-style intake bolt pattern. GM also offers a high-rise, single-plane intake with a Vortec bolt pattern that's used on some of its oval-track crate engines. In our quest for 400 hp, we tried the GM single-plane, as well as a Vortec-style Weiland Street Warrior dual-plane intake.

As expected, compared to the GM dual-plane, the single-plane trades off midrange power and torque for improved numbers above 4,700 rpm. Its 402 lb-ft torque peak is down by



[With the as-shipped mild GM cam, the GM dual-plane manifold (PN 12366573) makes more torque; GM's single-plane (PN 12496822) makes more peak power but is down on peak torque. The dual-plane's average total "area under the curve" for both torque and power was superior and occurred at a more reasonable rpm.]

DUAL-PLANE VS. SINGLE-PLANE

| TEST DESCRIPTION | UNIT OF MEASURE | OUTPUT | | CHANGE* | |
|--|-----------------|---------------------|-------|---------|------|
| | | MAX @ RPM | AVG. | MAX | AVG. |
| GM Eliminator single-plane intake PN 12496822 | Torque (Lb-Ft) | 402.0 @ 4,700 | 380.3 | -8.9 | -4.3 |
| | Power (HP) | 396.6 @ 5,600-5,700 | 308.4 | +11.7 | -1.9 |
| Weiland Street Warrior dual-plane PN 8502 | Torque (Lb-Ft) | 412.1 @ 4,000 | 383.5 | +1.2 | -1.1 |
| | Power (HP) | 385.1 @ 5,700 | 309.5 | +0.2 | -0.8 |

*Change over GM dual-plane and electric water pump baseline configuration. Test sweep: 2,500-6,000 rpm.



[On the engine dyno, Weiland's Street Warrior dual-plane high-rise intake (PN 8502) performed virtually the same as the GM dual-plane. In a real-world, in-vehicle application, its under-plenum air gap could cool the mixture, enhancing power. Subsequent tests utilizing a dual-plane were with this intake.

about 9 lb-ft, and occurs 300 rpm higher. Power is up by nearly 12 hp, with nearly 397 hp on tap at 5,600-5,700 rpm, the same rpm power peak as the dual-plane. Average output throughout the test range is off by about 4 lb-ft and 2 hp, indicating you are basically just shifting the rpm band higher. With only 1,000 rpm between torque and power peaks compared to 1,700 rpm with the dual-plane, this combo would be a real runner with a stick-shift trans and steep rear gears.

Weiland's Street Warrior dual-plane is representative of modern aftermarket high-rise dual-planes that typically include an under-plenum air gap. On a stationary engine dyno, we found it equivalent to the GM factory high-rise dual-plane, with nearly identical peak and average power and torque numbers. A dual-plane like the Weiland or GM offering would be the better choice for a daily driver with mild gears, especially with an automatic transmission.

DUAL-PLANE VS. SINGLE-PLANE INTAKE



STOCK VS. ROLLER ROCKER ARMS

Like its predecessors, the ZZ5 was delivered with OE, 1.50:1, stamped-steel rocker arms with a self-aligning (aka "guided") pallet tip and a separate ball-style pivot fulcrum. A popular upgrade is aftermarket full roller rocker arms with an integral trunion-bearing pivot and a roller tip. Besides the "cool factor," full-roller rockers reputedly aid durability, require less lubricating oil "upstairs," and reduce parasitic frictional losses. How much this really matters on a mild street engine has been a matter of debate.

The ZZ5's Fast Burn heads don't come with close-tolerance pushrod guideplates, so the roller tip needs to have alignment guides. Also required to clear the motor's as-delivered center-bolt valve covers is a narrower-than-normal rocker-arm body (conventional valve covers can be installed if desired on the dual-drilled Fast Burn heads). Using the Weiland Street Warrior dual-plane intake, we tested two different sets of Comp Cams' Ultra-Gold guided aluminum roller rockers: a 1.5:1-ratio set (PN 19015-16) and a 1.6:1-ratio set (PN 19016-16). Both were

a direct bolt-on with no clearance or valvetrain geometry issues.

Replacing the stock 1.5:1 pallet rockers with Comp's 1.5:1 Ultra-Gold roller rockers was worth 11.2 hp and 4.6 lb-ft at the peaks, with average overall torque and power gains throughout the test range of about five numbers. In other words, just bolting on a set of the same-ratio full-roller rockers raises peak power to the same level as the single-plane intake with conventional rockers, slightly boosts torque, and doesn't shift the curve higher. It's one of the easiest and most effective mods you can do.

But at 396 hp, the motor was still 4 hp shy of 400. Time to try those 1.6:1 roller rockers, which offer a 6.7 percent lift enhancement. The higher ratio put the motor over the top, with peak output rising to 404 hp and 420 lb-ft, still with the perfectly streetable dual-plane intake. The peak power rpm point was raised 200 rpm to 5,900, but even at the previous 5,700-rpm peak the motor was still making 403 hp. This indicates roller rockers are more stable on the top-end.



[The easiest and least expensive way to get to 400 hp while retaining the dual-plane intake's broad, street-friendly torque and power curve is to simply replace the ZZ5's as-shipped conventional 1.5:1 ball-pivot guided rocker arms with a bolt-in set of full-roller-fulcrum Comp Cams Ultra-Gold 1.6:1-ratio guided rocker arms.

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STOCK VS. ROLLER ROCKERS

| TEST DESCRIPTION | UNIT OF MEASURE | OUTPUT | | CHANGE* | |
|--|-----------------|---------------|----------|---------|------|
| | | MAX @ RPM | AVG. MAX | MAX | AVG. |
| Weiland Street Warrior dual-plane and Comp Cams Ultra-Gold 1.5:1 full-roller rocker arms | Torque (Lb-Ft) | 416.7 @ 4,100 | 388.8 | +4.6 | +5.3 |
| Weiland Street Warrior dual-plane and Comp Cams Ultra-Gold 1.6:1 full-roller rocker arms | Power (HP) | 396.3 @ 5,700 | 314.4 | +11.2 | +4.9 |
| Weiland Street Warrior dual-plane and Comp Cams Ultra-Gold 1.6:1 full-roller rocker arms | Torque (Lb-Ft) | 419.7 @ 4,100 | 391.7 | +7.6 | +8.2 |
| Weiland Street Warrior dual-plane and Comp Cams Ultra-Gold 1.6:1 full-roller rocker arms | Power (HP) | 404.0 @ 5,900 | 317.2 | +18.9 | +7.7 |

*Change over Weiland Street Warrior intake and 1.5:1 stock conventional rocker arms. Test sweep: 2,500–6,000 rpm.

HOW THE NEW ZZ6 GETS TO 405 HP

We achieved 400-plus hp with a high-rise dual-plane intake, the engine's as-shipped hydraulic-roller cam, and 1.6:1 full-roller rockers. But there's another way to get there if you examine the results carefully. Although we did not specifically test the combo, the GM single-plane intake and 1.5:1 full-roller rockers would also put the motor over the top. Individually, each of these bolt-ons is worth more than 11 hp in our tests, and it's a safe bet that collectively they would garner 20hp-plus over the 385 hp, no-accessory, baseline ZZ5 test configuration—albeit at some midrange torque loss. GM has elected to go just that route on the new ZZ6. Although we experienced no problems with 1.6:1 rockers, GM has to be concerned with production tolerance variations and corporate validation policies, so it apparently felt more comfortable going with full-roller, 1.5:1 rockers plus the single-plane intake. Based on our experience, the ZZ6 should more than achieve its officially advertised numbers: 405 hp at 5,600 rpm; 405 lb-ft at 4,600 rpm. By the time you read this, the latest member of the ZZ engine family should be available at your local Chevrolet Performance dealer: PN 19351532, base engine; PN 19351533, Turn-Key version.

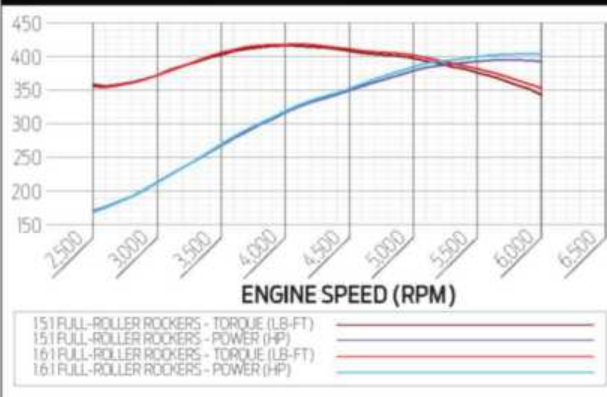
THREE HOTTER CAMS

Next to the cylinder head, the camshaft is a primary factor for establishing an engine's power potential. Even as it stepped up to Fast Burn heads, GM did not see fit to upgrade the 20-year-old cam profile. As for the valvetrain, although fine for the as-installed cam, the as-shipped valve-spring package is safe only to around 0.530-inch valve lift. Even that's not the end of the world because there are better aftermarket springs available. The real problem is the limited piston-to-valve clearance: The ZZ5 (and its successor ZZ6, for that matter) is no longer cylinder-head limited, it's piston-limited. Clearances must be validated with more than 0.550-inch valve lift and/or 230-degree duration (at 0.050-inch tappet lift) cams.

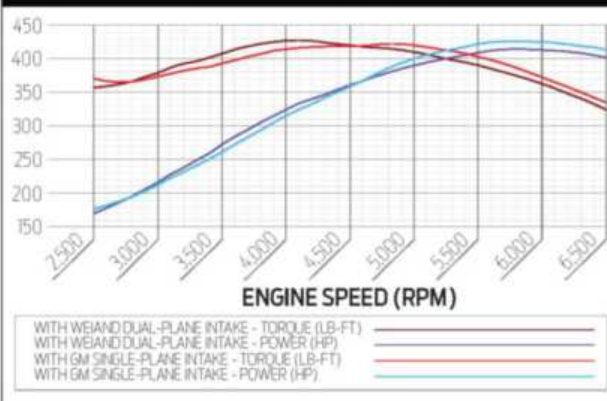
We compared three Comp Cams hydraulic roller camshafts to the as-shipped GM cam: an XFI profile, a 4-Pattern profile, and a special custom profile. To avoid clearance issues with the two largest cams yet provide directly comparable data, all three were tested with 1.5:1 rockers, although the XFI and 4-Pattern cams are designed and optimized for 1.6:1 rockers.

The GM springs were axed for the superior Comp beehive spring and retainer package to avoid spring pressure and coil-bind problems. As cams get bigger, the rpm range tends to move up, so the max rpm test-sweeps were extended from 6,000 to 6,500 rpm. All tests were run with the existing factory pushrods, hydraulic-roller

COMP CAMS ROLLER ROCKERS



COMP CAMS 269Q108 4-PATTERN CAM



lifters, and lifter-retention spiders and dogbones.

Comp's 268XFI hydraulic-roller represents the logical "first step up" from the relatively mild (by modern standards) as-shipped ZZ camshaft. It's really the minimum 21st-century cam we'd like to see in today's ZZ motor. Assuming 1.5:1 rockers, at least at this level you could even scrape by with the existing GM valvesprings. Compared to the best previous 1.5:1 rocker ratio/Weiland dual-plane configuration, the XFI grind is worth nearly 12 hp, peaking

at 408 hp at 6,000 rpm. That was also 4 hp more than the GM cam made with 1.6:1 rockers. At 417 lb-ft, torque production was within four numbers of the 1.6:1 combination. Average output was about the same, the engine trading off over-4,000-rpm gains for slight losses below that point.

Nearly all single four-barrel intake manifolds have unequal runner lengths. Comp Cams developed a series of four-pattern profiles that seek to optimize valve events for those different runner lengths. There are

TEST CAMSHAFT SPECIFICATIONS

Specifications for the hydraulic-roller cams tested in the ZZ5 engine. All lift values are in linear inches; all other values are in degrees.

| BRAND | SERIES & GRIND NO. | PART NO. | CYLINDERS ¹ | LIFT | | | | DURATION AT LOBE | | | | LOBE TIMING AT 0.050 LIFT | | | | LOBE CENTERLINE | | |
|-------|--|------------------------|------------------------|-------|-------|---------------------|-------|-------------------------|------|------------|------|---------------------------|-----------|-----------|----------|-----------------|-------|--------|
| | | | | LOBE | | VALVE (1.5:1 RATIO) | | ADVERTISED ² | | 0.050 LIFT | | INTAKE | | EXHAUST | | INT. | EXH. | LSA |
| | | | | INT. | EXH. | INT. | EXH. | INT. | EXH. | INT. | EXH. | OPEN | CLOSE | OPEN | CLOSE | | | |
| GM | ZZ3–ZZ6 (as-shipped cam in ZZ5 test engine) | 10185071 | All | 0.316 | 0.340 | 0.474 | 0.510 | 270 | 283 | 208 | 221 | 7 ATDC | 35 ABDC | 44 BBDC | 3 BTDC | 111 | 113.5 | 112.25 |
| | Xtreme Fuel Injection (XFI) CS 268XFI HR-13 | 08-466-8 | All | 0.357 | 0.354 | 0.536 | 0.531 | 268 | 271 | 218 | 224 | 0 BTDC | 38 ABDC | 49 BBDC | 5 BTDC | 109 | 117 | 113 |
| | 4-Pattern 269Q108 (1344ZS-1344IS/1347S-1347S HR 8.5-7.5) | 08-604-44 | 3–6 1–2, 7–8 | 0.375 | 0.367 | 0.563 | 0.551 | 269 | 281 | 217 | 227 | 6.5 BTDC | 30.5 ABDC | 46.5 BBDC | 0.5 ATDC | 102 | 113 | 107.5 |
| | Custom CS 13446S/1347S HR 113.0 | 08-000-09 ³ | All | 0.385 | 0.377 | 0.578 | 0.566 | 279 | 291 | 227 | 237 | 3.5 BTDC | 43.5 ABDC | 54.5 BBDC | 2.5 ATDC | 110 | 116 | 113 |

NOTES: ¹Lobe specs vary per cylinder on Comp Cams' 4-Pattern cams; outboard cylinders have bigger cam lobes to compensate for intake manifold runner length variations. ²0.004-inch tappet lift for GM; 0.006-inch tappet lift for Comp. ³Must append Grind No. to this generic custom grind Part No. when ordering.

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THREE HOTTER CAMS

Values in **RED** below are the highest max or average numbers recorded throughout the entire test series reported on in this article.

| TEST DESCRIPTION | UNIT OF MEASURE | MAX OUTPUT @ RPM | AVG. OUTPUT @ RPM RANGE | | MAX CHG.* | AVG. CHANGE @ RPM RANGE* | | IDLE VACUUM (IN-HG) @ RPM |
|--|-----------------|----------------------|-------------------------|--------------|-----------|--------------------------|-------------|---------------------------|
| | | | 2,500-6,000 | 2,500-6,500 | | 2,500-6,000 | 2,500-6,500 | |
| As-shipped GM ZZ5 cam, 1.5:1 roller rockers, Weiand dual-plane | Torque (Lb-Ft) | 416.7 @ 4,200 | 388.8 | — | — | — | — | — |
| | Power (HP) | 396.3 @ 5,700 | 314.4 | — | — | — | — | |
| Comp Cams 268XFI cam, 1.5:1 roller rockers, Weiand dual-plane | Torque (Lb-Ft) | 417.4 @ 4,200 | 389.9 | 383.3 | +0.7 | +1.1 | — | 14 @ 800 |
| | Power (HP) | 408.2 @ 6,000 | 316.8 | 327.3 | +11.9 | +2.4 | — | |
| Comp Cams 269Q108 4-Pattern cam, 1.5:1 roller rockers, Weiand dual-plane | Torque (Lb-Ft) | 427.1 @ 4,100 | 398.5 | 391.4 | +9.7 | +8.6 | +8.1 | 13.8 @ 850 |
| | Power (HP) | 414.0 @ 5,800 | 323.1 | 333.4 | +5.8 | +6.3 | +6.1 | |
| Comp Cams 269Q108 4-Pattern cam, 1.5:1 roller rockers, GM single-plane | Torque (Lb-Ft) | 422.4 @ 4,800 | 398.5 | 392.6 | -4.7 | 0.0 | +1.2 | 13.8 @ 850 |
| | Power (HP) | 426.7 @ 5,700-5,800 | 324.3 | 336.0 | +12.7 | +1.2 | +2.6 | |
| Comp Cams custom ZZ7/237 cam, 1.5:1 roller rockers, Weiand dual-plane | Torque (Lb-Ft) | 415.1 @ 4,200 | 388.3 | 384.1 | -7.3 | -10.2 | -8.5 | 13.2 @ 850 |
| | Power (HP) | 426.4 @ 6,100 | 317.3 | 330.3 | -0.3 | -7.0 | -5.7 | |
| Comp Cams custom ZZ7/237 cam, 1.5:1 roller rockers, GM single-plane | Torque (Lb-Ft) | 419.8 @ 5,000 | 391.7 | 388.7 | +4.7 | +3.4 | +4.6 | 13.2 @ 850 |
| | Power (HP) | 441.9 @ 6,000 | 320.8 | 335.4 | +15.5 | +3.5 | +5.1 | |

*Change over previous. Test sweep: GM, 2,500-6,000 rpm; Comp Cams, 2,500-6,500 rpm.



[Westech ran three different Comp cams grinds through the motor. Ultimately, cam selection was limited by piston-to-valve clearance issues, but all three delivered gains. Most impressive in terms of having broad, street-usable curves was Comp's 4-Pattern cam.



[For use with its hotter cams, Westech installed Comp Cams conical springs (PN 7228-16), retainers (PN 787-16), locks (PN 648-16), and spring seats (PN 4677-16) in place of the ZZ5's blue springs and retainers. No spring pocket mods or different-length pushrods were needed.

intake manifold runners), and 12 degrees more exhaust duration for the outboard cylinders. Compared to the previous cam, it was worth about 6 hp and 10 lb-ft at the peaks, and 8.6 lb-ft and 6.3 hp on average. Max output was now 414 hp and 427 lb-ft. The torque peak value would be the highest we saw in all tests.

Westech's Brulé felt the results justified trying the GM single-plane intake again—and he was proven correct: GM's intake was worth 12.7 hp over the dual-plane. Versus the XFI profile, that's an 18.5 total hp gain, bringing max output to 426.7 hp. Average power and torque output would also represent the high-water mark of all combinations tested. True, the engine was down slightly under 4,600 rpm, but the gains upstairs more than made up for it.

Comp Cams' custom grind had about the largest 0.050 duration (227/237 degrees) and valve lift (0.578/0.566 inch) that Comp felt was safe for the ZZ5's existing short-block. As further insurance, Comp ground the lobes with a 113-degree LSA, which at a given duration tends to provide a little more piston-to-valve clearance than Comp's usual default 110-degree street cam LSA.

With the dual-plane, the custom gained slightly over 12 hp at the peak compared to the 4-Pattern cam, but that only matched the peak power number of the single-plane with the 4-Pattern cam. Above its new 6,100-rpm power peak, it fell off the curve quickly. And overall it made less peak torque as well as average torque and power output than either intake did with the 4-Pattern.

The single-plane performed much better: Output jumped to nearly 442 hp and 420 lb-ft. The engine maintained over 440 hp from 5,900 through 6,400 rpm. Average power and torque output across the entire 2,500-6,500-rpm test range was up over the dual-plane about five numbers, with the gains primarily occurring on the top-end. However, the average numbers still did not quite equal those generated by the 4-Pattern/single-plane combo. At this level the single-plane definitely becomes the go-to choice if you're looking for maximum output and gear the combination to take advantage of it. We stuck with it and the custom cam for the next series of carburetor and ignition tests.

actually four lobe patterns ground on the same billet: one intake and one exhaust lobe profile for the outboard cylinders, and one intake and one exhaust lobe profile for the inboard cylinders. Although proven on full-race motors, previous tests of this technology in street or dual-purpose hot rod engines has frankly met with mixed results. Sometimes it helps, sometimes it doesn't.

What we can say is on a ZZ motor with Fast Burn heads, the 4-Pattern unequivocally helps! Comp's 269Q108 4-Pattern cam had about the same advertised duration as the XFI grind on the intake side, 10 degrees more exhaust duration for the inboard cylinders (corresponding to the shorter

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CARB VS. CARB

Up to this point, the as-shipped 670-cfm, electric-choke, vacuum-secondary Holley carb had performed flawlessly, with only slightly richer jets on the secondary side required. Now that we were into a single-plane intake and fairly healthy cam, we wondered whether the engine could do better with a more radical double-pumper-style competition carb. Most ZZ customers will also probably buy the base engine, which doesn't come with an installed carburetor. We had Holley send us two of its latest, all-aluminum, Hard Core Gray Ultra carbs.

First up was a 650-cfm Ultra XP carb with booster inserts, contoured venturis, an integrated idle bypass valve, and no choke tower. This carb is really intended for use in drag-race, circle-track, or extreme high-horsepower engines. Jetting was OK out of the box, but the carb failed to make any additional power.

Next we tried a modernized version

of Holley's venerable 750-cfm double-pumper. It also comes in Hard Core Gray with an aluminum baseplate and metering blocks, but retains a choke tower and a manual choke. Its primary application would be in lightweight vehicles with a manual trans or automatics with a high-stall converter and low gearing. The carb was lean out of the box; Brulé had to richen the primaries from No. 72 to No. 75 jets, and the secondaries from No. 80 to No. 84. Once the jetting was sorted out, it raised peak output to 445 hp—the high-water mark power number seen in these tests. Peak torque and all average numbers were virtually unchanged. Whether the expense of this carb is worth 3 hp is for you to decide. Also remember that full-throttle engine-dyno pulls are not necessarily reflective of a combination's real-world driveability. It seems GM and Holley obviously did their homework with the ZZ5's carb.

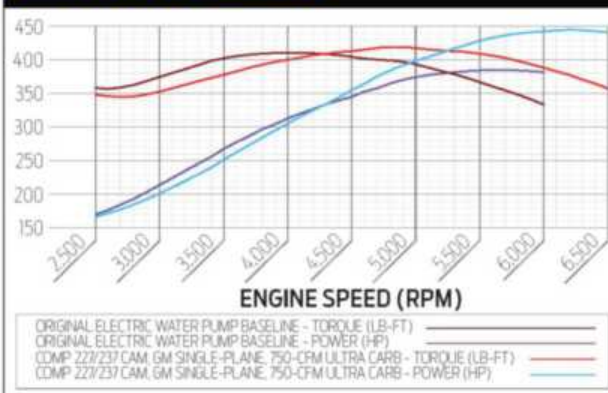
CARB VS. CARB

Value in **RED** below is the highest max power number observed on this article's test engine.

| TEST DESCRIPTION | UNIT OF MEASURE | OUTPUT | | CHANGE* | |
|--|-----------------|----------------------|-------|---------|------|
| | | MAX @ RPM | AVG. | MAX | AVG. |
| Holley 0-80820HBX 650-cfm Ultra XP double-pumper | Torque (Lb-Ft) | 418.9 @ 4,900 | 387.7 | -0.9 | -1.0 |
| | Power (HP) | 441.7 @ 6,200 | 334.5 | -0.2 | -0.9 |
| Holley 0-76751HB Ultra double-pumper | Torque (Lb-Ft) | 419.6 @ 4,800 | 388.6 | -0.2 | -0.1 |
| | Power (HP) | 445.1 @ 6,200 | 335.5 | +3.2 | +0.1 |

*Change over previous Comp Cams' ZZ7/237-degree custom cam, GM single-plane, and as-shipped 670-cfm Holley vacuum-secondary carb. Test sweep: 2,500–6,500 rpm.

MAX OUTPUT VS. BASELINE



[Westech tried two trick double-pumper Holleys. Both have lots of high-end options such as replaceable air bleeds. A 650-cfm Ultra XP made no more power than the Turn-Key engine's as-delivered Holley. A 750-cfm Ultra (on engine) raised max output to 445 hp, the highest observed power number in these tests.]



MSD LLC

[Westech tested an MSD ignition upgrade kit (PN 84741) that includes a Pro Billet Ready-to-Run, three-wire, internal-module distributor (PN 8360), a Blaster SS coil (PN 8207), a universal set of 8.5mm Super Conductor Wires, Pro-Clamp separators, and even a billet distributor hold-down clamp. It performed on a par with the Turn-Key's large-cap integrated HEI distributor.]

MSD IGNITIONS

| TEST DESCRIPTION | UNIT OF MEASURE | OUTPUT | | CHANGE* | |
|--|-----------------|----------------------------|-------|---------|------|
| | | MAX @ RPM | AVG. | MAX | AVG. |
| MSD Pro Billet Ready-to-Run distributor, Blaster SS coil, and universal spark plug wires | Torque (Lb-Ft) | 420.9 @ 4,900 | 388.6 | +1.3 | 0.0 |
| | Power (HP) | 443.9 @ 6,200 | 335.3 | -1.2 | -0.2 |
| As above plus MSD Digital 7 Ignition module/control box | Torque (Lb-Ft) | 419.6 @ 4,900 | 388.8 | 0.0 | +0.2 |
| | Power (HP) | 442.2 @ 6,100–6,200 | 335.3 | -2.9 | -0.2 |

*Change over previous Comp Cams' ZZ7/237-degree custom cam, GM single-plane, 750-cfm Holley Ultra double-pumper carb, GM large-cap HEI distributor with internal coil, and as-shipped GM spark-plug wires. Test sweep: 2,500–6,500 rpm.

MSD IGNITIONS

Both base and Turn-Key ZZ engines come with a tried and true coil-in-cap GM HEI distributor, similar to the unit used on millions of the General's cars and trucks from the mid-1970s through the early 1980s, but with a centrifugal advance curve suited to a performance application instead of a smog motor. The distributor's large cap may not clear some firewalls or large air cleaners. Base ZZs also don't come with spark-plug wires. MSD offers a kit that it says has "all the parts needed to fire up your new GM crate engine": a Pro Billet Ready-to-Run three-wire internal-module small-cap distributor, a complimentary separate coil, and a universal spark-plug wire set. Using the combination from the previous carb tests—the 750 double-pumper carb

on the GM single-plane intake and Comp's ZZ7/237 custom cam—these parts generated nearly the same torque and power numbers as the HEI distributor, despite the fact the HEI had more mechanical advance in the distributor, but reached total advance at a slightly higher rpm than the MSD unit (total timing was the same for each, at 35 degrees).

Westech then ran another test sequence, connecting the distributor to its default dyno MSD Digital 7 multispark standalone module and HVC II coil. Again, virtually no change in the numbers. It appears that at this power level the Turn-Key's GM HEI rig is good enough, but if you need more air cleaner or firewall clearance, MSD is ready to step in.



✓Yes



✓Yes



xNo



✓Yes



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CARB SPACER, OLD GM NASCAR INTAKE

At this point, the engine was stuck at 445 hp. We really wanted to see 450 hp—just five measly horsepower more. We had two more cards left to play. First, we tried a 1.25-inch-tall Wilson Manifolds' open carb spacer, added to the parts used in the previous ignition test—still stuck around 445 hp.

How 'bout a more aggressive intake manifold? The Fast Burn heads have a dual intake-manifold bolt pattern, in theory permitting them to accept old-school conventional small-block Chevy intakes in addition to the Vortec-style intakes we'd been using so far. We say "in theory" because the port roof on Fast Burn heads (as well as other Vortec-type heads) is about 0.240-inch higher than older-style 23-degree valve-angle conventional heads. Never

mind the port mismatch of using an earlier intake: We're not aware of any 23-degree, standard-port-location intakes with enough material to seal against this taller roof.

GM still offers a "raised-runner," conventional bolt-pattern, single-plane with a 0.211-inch taller roof left over from the mid-1980s when NASCAR Cup cars still ran 23-degree heads. Maybe it would have enough material to seal-up and get us those last few horses? No, and no. There's still a massive vacuum leak and even with the Wilson spacer it actually lost about three numbers. But at least we determined that you better stick with Vortec-style intakes on Fast Burn-equipped engines.

WHAT WE LEARNED

As delivered, at least on Westech's dyno, the ZZ5 is about a 385hp engine without driven accessories. But to get more than 400 hp, all that's needed is a set of 1.6:1 full-roller guided rocker arms. Comp Cams' 4-Pattern cam and GM's single-plane will get you into the 425hp range with well-rounded torque and power curves while still maintaining decent idle vacuum. Ultimately, 440–445 hp with some torque loss is achievable with the custom Comp grind we tested. At that level, the as-shipped GM HEI distributor and (with proper jetting) the as-shipped Holley carb can still do the job.

Conservatively, an unported Fast Burn head's intake runner flows around 235 cfm at 0.600-inch lift at 28 inches of water, which means it

should be capable of supporting at least 485 hp in normally aspirated trim. But as these tests indicate, around 445 hp is the cap due to piston-to-valve clearance issues on the existing short-block that in turn limit optimum cam profiles. If there's ever to be a ZZ7, GM needs to install a better piston with generous valve notches. While it's at it, make it a forging with around 10.5:1 compression; at a nominal 9.7:1, the ZZ5 and ZZ6 lost about half a point from the 10.3:1 ZZ4 due to the Fast Burn head's larger 62cc combustion chamber compared to the old L98 head used on earlier ZZ engines with its 58cc chamber. Now that would be the king of 350 crate motors!

CARB SPACER, NASCAR INTAKE

| TEST DESCRIPTION | UNIT OF MEASURE | OUTPUT | | CHANGE* | |
|---|-----------------|---------------|-------|---------|------|
| | | MAX @ RPM | AVG. | MAX | AVG. |
| Wilson Manifolds 1.25-inch-tall spacer on GM Vortec bolt-pattern single-plane intake manifold | Torque (Lb-Ft) | 421.4 @ 4,900 | 389.0 | +1.8 | +0.3 |
| | Power (HP) | 444.9 @ 6,200 | 335.9 | +2.7 | +0.6 |
| GM standard bolt-pattern, raised-runner, single-plane intake for 23° valve-angle heads plus Wilson spacer | Torque (Lb-Ft) | 420.9 @ 5,000 | 389.2 | +1.3 | +0.4 |
| | Power (HP) | 444.9 @ 6,200 | 335.9 | +2.7 | +0.6 |

*Change over previous Comp Cams' ZZ7/237-degree custom cam, GM single-plane with no spacer, 750-cfm Holley Ultra double-pumper carb, and MSD distributor, Digital 7 box, and spark plug wires. Test sweep: 2,500–6,500 rpm.



[GM still offers a raised-runner Bow Tie intake (PN 10051103) that it used on its 1980s-vintage 23-degree Bow Tie racing heads. It physically bolts up to the Fast Burn heads' dual intake-manifold bolt pattern. Elway Chevrolet sent us one to try. No gain, massive vacuum leak, even with the recommended GM or Fel-Pro dual-pattern gaskets.



[The intake gasket's sealing bead is higher than the NASCAR intake's roof. If this high-port intake won't seal, any 12-bolt, standard runner location unit doesn't have a prayer, either!]

Contacts

CHEVROLET PERFORMANCE PARTS; Grand Blanc, MI; 800.577.6888 (nearest dealer); ChevroletPerformance.com

COMP CAMS; Memphis, TN; 800.999.0853 or 901.795.2400; CompCams.com

FEL-PRO (FEDERAL-MOGUL CORP.); Southfield, MI; 800.325.8886; FMe-cat.com

HOLLEY PERFORMANCE PRODUCTS; Bowling Green, KY; 800.HOLLEY1 (nearest dealer), 270.781.9741 (tech), or 270.782.2900 (general); Holley.com

JOHN ELWAY CHEVROLET ON BROADWAY; Englewood, CO; 800.345.5744 or 303.761.1286; JohnElwayChevrolet.com

MSD LLC; El Paso, TX; 915.857.5200 (main), 888.673.7859 (tech) or 915.855.7123 (tech); MSDignition.com

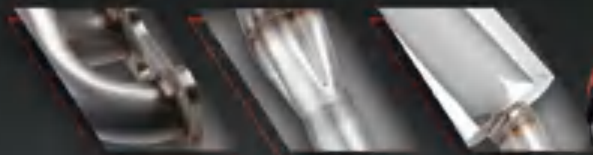
WESTECH PERFORMANCE GROUP; Mira Loma, CA; 951.685.4767; WestechPerformance.com

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I don't advocate breaking any speeding laws, but what happens if a bit of empty road overcomes your good citizenship? You become the lion, and the hunting dentist's name is Dr. Johnny Law. Are you nimble and aware, or fat and lazy?

I just got a speeding ticket, the first in many years, and only the second in my life. I'm

annoyed, of course, but not for the reasons you might think. It's not the expense or the traffic-school time, but the fact that I was outsmarted. I didn't see the officer before he saw me. "Why don't you use a radar detector on those long drives?" asked a friend. "Why don't you use cruise control?" asked another. To them I say, "Where's the challenge in that?"

Perhaps my driving preferences are due to my skills developing all in pre-1975 cars, where every creak and tweak of the steering wheel could mean the whole thing is about to fall apart, but I like to make the decisions on the road. The best part of driving is that connection between my foot, my eyes, my hands, and the direction we're headed. I enjoy the slight ebb and flow of gaining on distant traffic, then dropping back to a safe following distance before making the pass. I like the sense of control that it gives me to know exactly what speed I'm traveling and that it's all up to me to go faster or bring it down a notch. There is a lot of talk of "connected car technology" with new cars, but if you're going to spend your driving time answering emails or checking Facebook, you might as well take the bus. I'm all about being a connected driver.

►HOTROD.COM/Elana-Scherr

[Worst part of my 88-mph ticket? The officer didn't think my joke about going back in time to warn myself was funny.]

| | | | | |
|---------------------------|--|------------------------------|--------------|-----------|
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Thom On Design

The Box With Four Tires and a Top



Ah, the 1980s. It was a rough patch for American automotive design. All you have to do is look at the 1980 Pontiac Grand Prix to see that.

What was so bad about the GP? If you look

at where the fender, hood, and front meet, there's a corner. A sharp corner. It's a styled car with no transitioning of surfaces, no finessing of forms—just four actual corners bonked onto each, well, each corner.

GM had been hitting long balls with its swoopy, high-styled Firebirds, Camaros, and colonnade offerings through the 1970s. It was the leader in design for at least a few decades. But when Volkswagen came out with its replacement for the venerated Bug, the 1974 Rabbit—with its Giorgetto Giugiaro-designed fantastical folded-paper design language—all of the American car companies followed suit.

Ford and Chrysler also spread the flat-box love with their 1980 Thunderbird and Chrysler K-car, respectively.

But it was Pontiac that took it to the extreme with the 1980 GP. Design-wise, it was a shiny box with four tires and a car roof attached. And Pontiac wasn't through leading with the bad.

By 1990, it brought the world plastic-ribbed cladding, available on most of its models, including the family friendly Trans Sport minivan. We'll relieve you of that fiasco for now.

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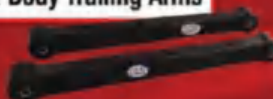
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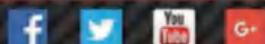


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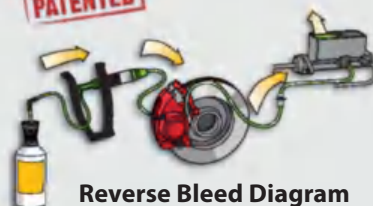
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For engines with adjustable, stud-mounted rocker arms and hydraulic lifters, stock specs typically call for a conservative 1 turn past the zero-lash point. Turning the rocker arm adjustment nut a lesser amount after reaching the zero-lash point positions the hydraulic lifter's internal plunger closer to the lifter plunger's snap-ring retainer. At high rpm, this delays hydraulic lifter pump-up because the plunger can't move far enough to interfere with valve closure when hydraulic force overcomes valvespring pressure. In fact, some racers even adjust the nut as close as 1/8 turn or less down from zero lash, which positions the hydraulic lifter plunger practically against the snap ring, effectively causing the hydraulic lifter to act like a mechanical lifter because it can't take up any clearance in the valvetrain. Running tight plunger-to-retainer clearances can be risky if using standard lifters that have a paperclip-type retaining ring because hydraulic pressure may cause the plunger body to pop out of the groove, resulting in catastrophic failure. Lifters with full-contact internal Truarc-style snap rings can better withstand these tight clearances. For long-term street durability with a high-perf cam, adjust lifters with Truarc-type retaining rings 1/4–1/2-turn down from zero lash; adjust paperclip retaining-ring lifters 1/2–3/4-turn down from zero lash.

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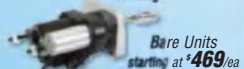


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[With his custom Cad well on the way to full recovery, owner Murray Pfaff is smiling once again. He's owned the car since 1986.



[The 1956 Cadillac has got us longing for the days of real heavy metal. Power is from a big 500ci Caddy V8.



[Mechanically, the noisy starter was traced to a warped flexplate plus incorrect starter drive pinion-to-flexplate gear-tooth clearance.

Murray Pfaff's Starter No Longer Hangs-Up On His Caddy's Flexplate, But It's Still Noisy Under Crank. We're Gonna Fix It.

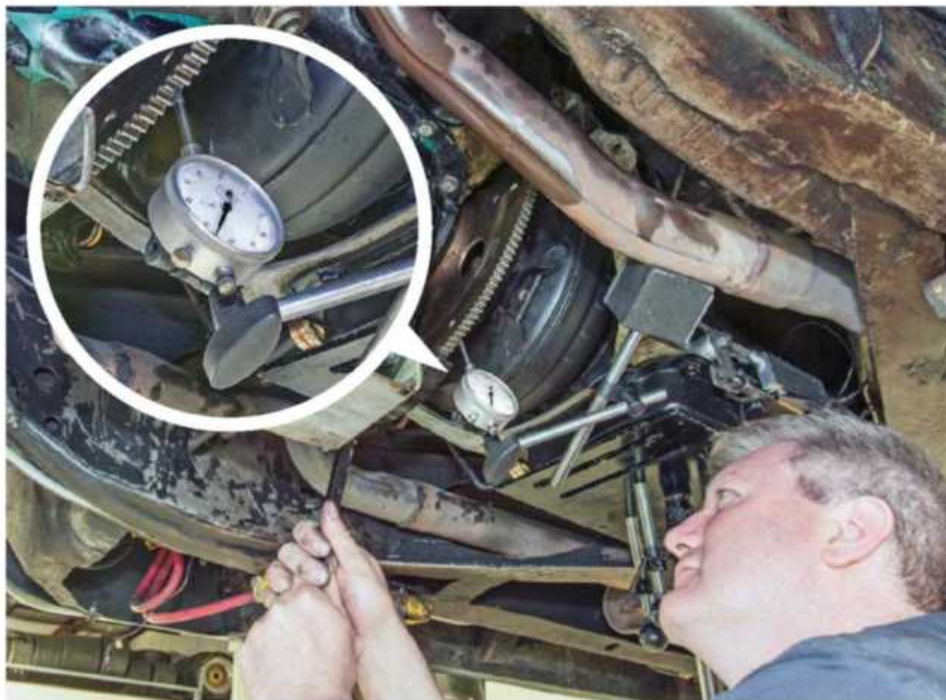
✍ Marlan Davis 📷 Will Handzel

THE STORY SO FAR

Last month, we saw how the starter drive-pinion on Murray Pfaff's 500ci-powered 1956 Cadillac wouldn't disengage from the flexplate once it got the motor up and running. RM Motorsports replaced the defective electrical components and revised the wiring harness to resolve the issue, so at least there were no more hang-ups. However, the starter was still noisy under crank, pointing to some sort of mechanical interference issue between the starter drive and flexplate ring gear.

THE DIAGNOSIS

RM's Joe Holyfield unbolted the starter for visual inspection. He observed excessive wear on the starter drive pinion-gear teeth as well as on the flexplate ring-gear teeth—a sure sign of mechanical interference. Even worse, further checks revealed the flexplate had excessive runout; it was not round, but oval-shaped! Both the starter and the flexplate would need to be replaced. After removing the torque converter



[Under crank, the starter had an awful "wroooow, wroooow, wroooow" wail. Checking the flexplate every 45 degrees with a dial indicator, RM's Joe Holyfield found it seriously out-of-round. Runout was an excessive 0.060–0.070 inch; 0.005–0.010 inch is considered normal.

to gain access to the flexplate-to-crankshaft mounting bolts, Holyfield noted that several bolt heads were completely sheared off. Did the failed bolts cause the gear-tooth wear, or did

excess vibration and binding induced by the starter hang-up issue cause the bolt failure? Yet a third possibility is the bolts were slightly too long and were bottoming out on the crank. It's

impossible to know what started the chain of failure, but as a precaution, Holyfield decided to replace all six flexplate bolts as well.

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[After fixing most of the electrical woes last month, RM Motorsports' Joe Holyfield went to work on the noisy starter and hot-soak issues.



[A Cad Company flexplate (bottom) replaced the heavily worn unit (top). A new NAPA starter was then shimmed for proper gear clearance.



[Fixed for good and ready to light-up Royal Oak, Michigan's streets! Dig the flamethrower exhaust system. Houston, we have ignition.



[Flexplate removal begins by unbolting the driveshaft's rear U-joint yoke from the rearend's pinion flange. Prevent driveshaft out-of-balance issues by marking the rear U-joint yoke and rearend pinion alignment (circle) so the driveshaft yoke can be reinstalled in the same orientation. Slide the front slip-yoke out the back of the trans, then install a plug to prevent a trans fluid leak.

THE FIX: FLEXPLATE AND STARTER

Pfaff's aftermarket torque converter had the "small" GM mounting pattern, which requires a dual-drilled flexplate, a unit not usually found stock on

Caddy V8s. The Cad Company's relatively affordable, stamped-steel, dual-pattern unit was the easy fix.

The flexplate mounting screws were harder to come by. GM no longer stocks original $\frac{7}{16}$ -20 \times $\frac{1}{16}$ -inch Caddy flexplate screws, and we couldn't find any auto-parts-store equivalents. The

expedient, affordable solution: Use a Pioneer bolt kit officially listed for 1986–1990 Buick V6 engines. PN PG-635 (boxed) or S-1135 (carded) contains six $\frac{7}{16}$ -20 \times $\frac{5}{8}$ -inch bolts. To keep the slightly longer "Buick" bolts from bottoming out against the holes in the crank, Holyfield installed them with 0.063-inch-

thick precision AN960-716 flat airframe washers.

A brand-new NAPA high-torque starter motor was installed and the engine cranked over. But the howling gear clash was still present, confirming there was a clearance problem even with a brand-new starter drive-pinion and flexplate. Typical causes are slightly mislocated block starter mounting holes, a slight change in the crank center-line location from align-boring the block, or just tolerance stack-up among different parts.

Using a drill bit to measure the clearance between the two gears,

“It's a car I'm no longer afraid to drive. I can turn the key on with confidence.”

— Murray Pfaff



[Remove the trans from its support or crossmember while supporting it on a jack. Unbolt the torque converter from the flexplate. Slide the trans and torque converter back out of the way to gain access to the flexplate and unbolt it from the crank. On Pfaff's engine, two of the six critical flexplate-to-crank attaching bolts had failed.]



[The torque converter-to-flexplate attaching bolts were reusable once Holyfield cleaned them up with a wire wheel. Holyfield used all-new bolts to attach the flexplate to the crank.]



[Holyfield installed both the new flexplate and reused torque converter bolts with "red" Loctite threadlocker. "I have had good luck with this procedure on race cars," he explains. "I don't want anything to loosen."]



[With stock Caddy replacement flexplate bolts no longer available, Holyfield used slightly longer Pioneer Buick V6 flexplate bolts plus AN washers to act as a spacer. Flexplate and torque converter bolts were tightened to 60 and 30 lb-ft, respectively, using a star pattern. Note the flywheel holder used to prevent engine rotation during the fastener-tightening sequence.]

Holyfield found the starter was too far away from the flexplate (insufficient tooth engagement). "That was surprising," Holyfield says. "It's the opposite of what you run into 99 percent of the time where it's too close." He shimmed the outer starter mounting bolt to move the unit closer to the flexplate. Noisy starter cured!

THE FIX: STARTER HOT-SOAK

Now that the Caddy could be reliably started and driven, Pfaff's old hot-restart problem came back. The typical scenario for a GM hot-restart issue is you drive the car long enough for everything to get hot, park the car for about 10 minutes, and then attempt a restart. At this time, the GM's starter "click, click, no crank" or extremely slow, lazy crank syndrome rears up. The cause is usually excessive voltage drop somewhere in the cranking (solenoid) side of the ignition-starter circuit. Heat increases resistance, which reduces voltage. "There's not enough current to engage the solenoid," Holyfield explains. If you're patient enough to let the car cool down, it eventually restarts. As related last month, this is Pfaff's original issue that he'd tried to resolve years ago with the problematic and unreliable secondary mechanical solenoid that RM removed.

Instead of a Band-Aid approach, RM's sanitary solution is to find where in the circuit the voltage drop occurs, then directly address that issue. This is accomplished by connecting a common digital voltmeter between the battery and the connection being checked, then cranking the motor with the ignition coil disconnected. The Caddy's starting "high-side" starting circuit (battery positive-to-solenoid "B" terminal) checked good, as did the Ground return, but there was significant drop on the cranking side between the ignition key and solenoid "S" terminal.

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Where was the drop occurring? Holyfield back-traced the circuit, checking the voltage loss at every terminal, splice, and connector from the S terminal back to the ignition key. Holyfield continues, “On the Cadillac, although we did find a slight drop at the [ignition] key, the main source turned out to be the microswitch at the trans that was being used as a neutral safety switch.” It takes up to 40 amps to kick in the solenoid plunger on a heat-soaked GM starter. The microswitch wasn’t rated for that much juice—hence the voltage drop.

Holyfield fixed the problem by wiring in a standard ISO relay between the keyed ignition switch and the microswitch (see electrical schematic, page 102). “I also ran new hook-up wires between the switch, relay, neutral switch, and solenoid,” Holyfield concludes. As a final failsafe, to insulate the starter from heat given off by the Caddy’s exhaust manifolds, Holyfield also fabricated a custom heat-shield.

THE RESULTS

Rerouting wires, soldering all connections, installing a higher-capacity master kill switch, and axing the troublesome secondary solenoid in favor of a relay installed where it would do the most good addressed the electrical side of Pfaff’s starting issues. Installing a new flexplate and starter shimmed to the correct tooth engagement-depth corrected the mechanical side. A happy Pfaff was able to drive the now-reliable car all summer with no problems.

WHAT STARTER WHINE CAN TELL YOU ABOUT GEAR CLEARANCE

A high-pitched whine or clanging sound under engine crank that occurs *before* the engine starts indicates excessive starter pinion-to-flexplate or flywheel ring-gear clearance—as was the case here on Pfaff’s Caddy. However, a high-pitched whine *after* the engine starts when you release the key indicates not enough clearance.



[There needs to be 0.025–0.035-inch clearance between the valley and the crown of the starter pinion and ring-gear teeth. When the new starter and flexplate remained noisy under crank, Holyfield decided to check this critical dimension.



[An equivalent check can be performed in an unpowered state: Use an expedient pick or hook tool to pull the pinion out to engage the ring gear while slightly rotating the flexplate by hand. These checks established the “root” cause of Pfaff’s noisy starters: Their mounting location was too far outboard.



[Check clearance by applying 12 volts to the solenoid “S” terminal *only* (don’t connect the battery cable to the “B” terminal). This engages the solenoid but won’t spin the starter. Don’t leave the solenoid engaged over 30 seconds or it may overheat. A 1/32-inch drill bit or a paperclip make for good gauging tools. Here the bit is a loose fit, indicating excessive clearance.



[RM used a CVR shim kit to adjust the tooth-engagement clearance. Shimming *only* the outboard starter mounting bolt reduces clearance, moving the drive-pinion inboard, closer into the ring-gear. Pfaff’s setup required a 0.119-inch-thick shim pack on the outboard side. If necessary to increase clearance, shim *both* starter bolts.

HOW TO DO A VOLTAGE-DROP TEST

Many common electrical difficulties in high-current-draw electrical circuits like the starting or charging circuits can be diagnosed via a voltage-drop test performed using a common digital multimeter. This test permits breaking down a complex circuit into individual components to home in on the real problem. A voltage-drop test must be “dynamic,” meaning voltage drop can only be measured when a load is applied to the circuit, such as when the engine is cranking.

To perform a voltage-drop test, set the meter on “volts” and place one lead on the battery’s positive post and the other lead on the terminal or connection you want to check. Ground the coil wire to prevent the

engine from starting. Crank the engine no more than 15 seconds to prevent the starter from overheating.

The number displayed by the multimeter during the test indicates the voltage amount lost to resistance through a connection or a cable in the circuit. According to Holyfield, “I want the starter to receive 10.5 volts minimum during crank, so total voltage drop in the cranking circuit should not exceed 1.5 volts. The voltage drop on Pfaff’s high side—battery-to-starter solenoid B terminal—was minimal. But the low ‘actuation’ side loss was about 4½ volts. He was only getting 8 volts to the S terminal when the engine got heat-soaked.”



[This photo simulates performing a voltage-drop test on the battery’s positive cable. One lead is connected to the positive battery post and the other to the starter solenoid’s large B terminal. Here the meter reading is zero (no voltage drop)—both because the cable was so short and the circuit was not seeing any load (the starter wasn’t actually cranking an engine).

Jeff Smith

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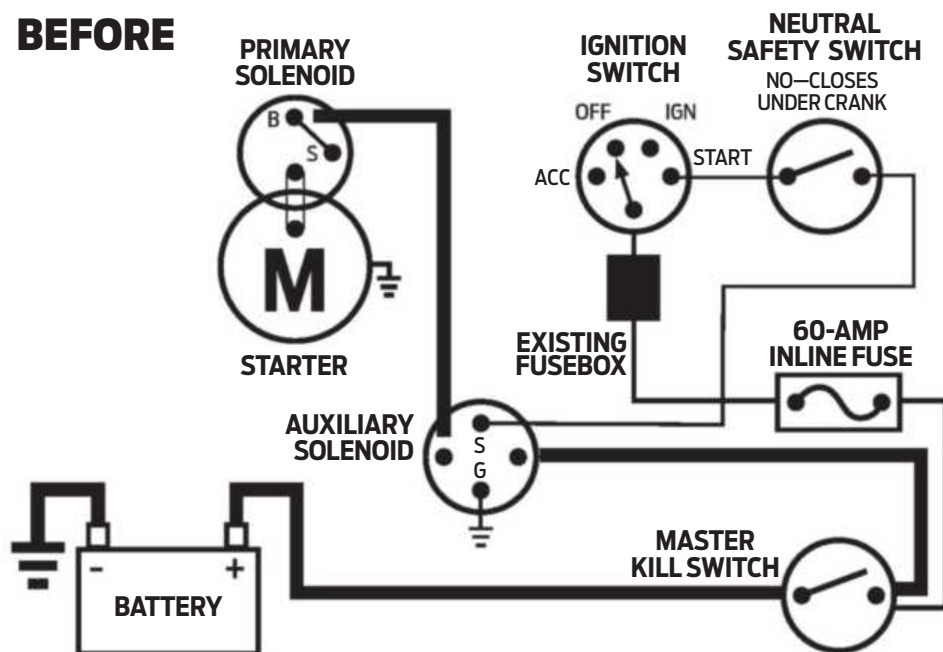
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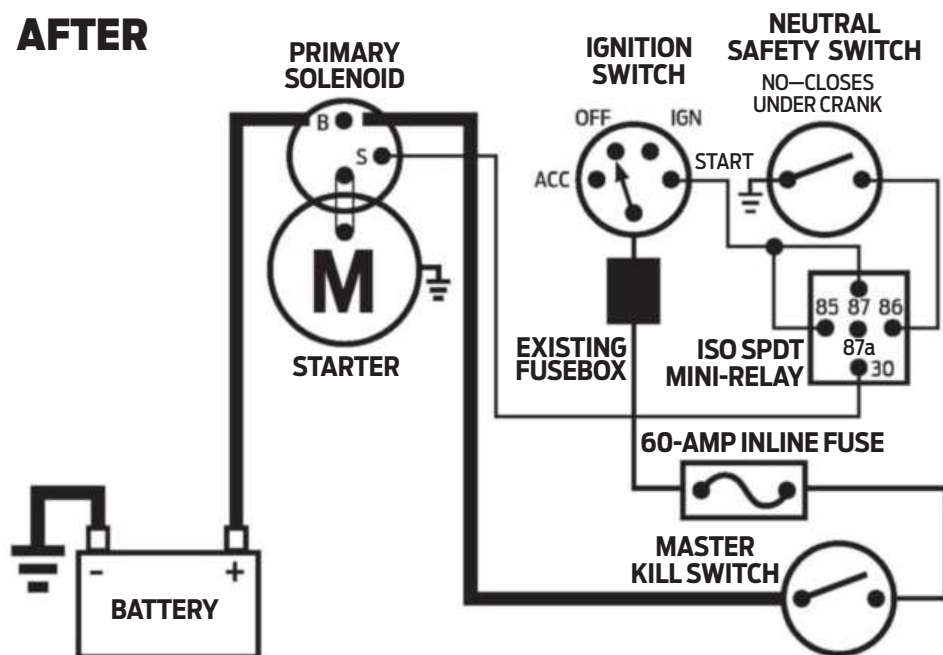


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BEFORE



AFTER



[RM] traced the voltage drop to a microswitch on the automatic trans linkage being used as the neutral safety switch that wasn't rated to handle the increased current demands of a heat-soaked starter. Yeah, the ignition wire is here, somewhere. Large wire bundles get hotter than individual wires, which can also generate additional resistance and voltage-drop.



[RM's solution: Wire-in a relay between the keyed ignition switch and neutral safety switch. The neutral safety switch now sees only the low-amp current needed to activate the relay. Even on a hot day with a heat-soaked starter, Holyfield says power at the S terminal has "improved to the 11-volt range."

STARTER MOTOR WIRING

BEFORE

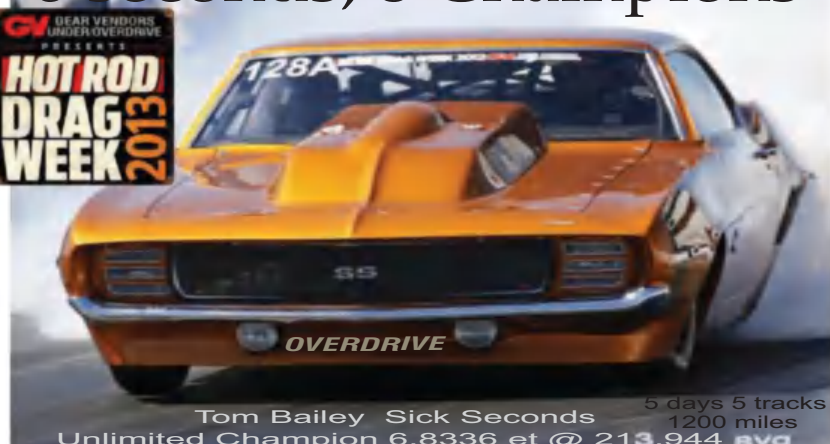
As detailed in the March 2015 issue, battery current is supplied to one side of a manual master kill switch at all times. Manually closing the switch lever allows current to flow to the rest of the car, including the ignition switch and the high-current side of an auxiliary mechanical solenoid installed by Pfaff years prior in his attempt to fix a hot-restart issue. When the keyed ignition switch rotates to "start," and the trans is in "Park" or "Neutral," current flows through the transmission neutral safety switch (NSS) to actuate the auxiliary solenoid, which kicks in and allows battery power to flow to the starter-mounted primary solenoid B terminal. A jumper between the solenoid's B and S terminals kicks-in the solenoid plunger. The drive pinion engages the flexplate ring gear and the motor rotates. This scheme eliminates voltage drop at the starter-mounted solenoid, but Holyfield says the secondary solenoid can induce a mechanical delay, possibly contributing to Pfaff's original starter disengagement issue addressed last month. In any event, Pfaff's original kill switch and secondary solenoid were of poor quality and were internally fried.

AFTER

An auxiliary solenoid is no longer used. Battery current travels a shorter path directly to the starter solenoid's B terminal, which (as in an OE GM setup) is hot at all times. A second large battery cable connects the solenoid B terminal to the master kill switch. When the switch lever is manually closed, current flows to the rest of the car, including the ignition switch. The primary source of Pfaff's hot-restart voltage drop was isolated this month to an underrated trans NSS. RM added a standard ISO SPDT NO/NC universal mini-relay to fix the issue. With the ignition switch in "start," current is supplied to relay terminals 85 and 87. (87a isn't used for this application.) Current flows from low-side terminal 85 to terminal 86 and out to the NSS, which closes and grounds the low-side circuit and kicking in the relay. That allows high-side current to flow from relay terminal 87 to terminal 30, and on out to solenoid terminal S. The starter solenoid actuates, engaging the flexplate and spinning the motor. With this scheme, the NSS isn't overtaxed as it serves only as a relay actuation device and does not impede the 40-amp current flow needed by a hot-soaked solenoid.

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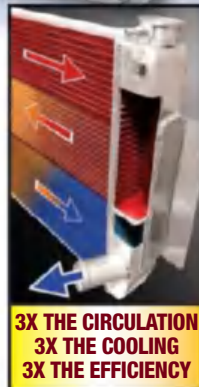
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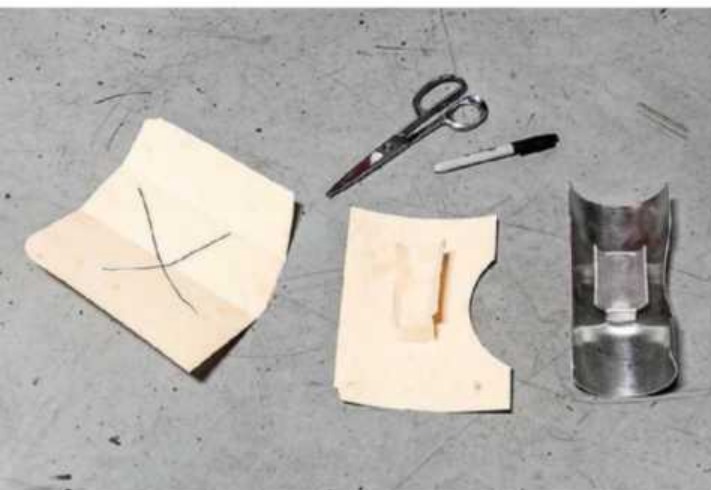
Includes the major parts used in Phase 2 (this article) required to fix the problem. For Phase 1 parts list, see the March 2016 issue. Labor is listed only for machining operations the average home mechanic cannot generally perform in his garage. Does not include any shipping charges or sales taxes. All dimensions are in linear inches, except as noted. Phase 2 priced 12/01/2015 and subject to change.

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| | WASHER, flat, airframe, 7/16, 0.063 thk, steel, cadmium-plated (use w/ listed flexplate screw) | AN960-716 | 6 | Aircraft Spruce | \$0.30 |
| BREEZE (NORMA) | CLAMP, worm-drive, perforated, SAE J1508 Type F, stainless steel, 1 1/8"-2 1/2" range, 3/16 band, 3/16 slotted-hex screw ¹ | 200-32H | 2 | Aircraft Spruce | \$2.98 |
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NOTES: ¹Fabricated from listed sheet aluminum and worm-drive clamps. ²Original GM Cadillac 7/16-20 x 0.5265 factory screw is no longer available from any source. Install the slightly longer Buick screws with the listed AN960-716 airframe washers using red Threadlocker.

LESSONS LEARNED

"As with many hot rods, a lot of parts had been thrown at the car trying to fix the problem," Holyfield sums up. "The starter had been installed wrong—not shimmed properly—and had eaten away at the flexplate and starter pinion gear. The wiring was banded to try to help the problem. A lot of the details were overlooked and a couple of small problems added up to a big one. You have to remember it's called a 'starting system' because there are several subsystems that all need to work together to make the vehicle start."



[RM also tried to minimize heat-soak problems by fabricating a custom starter heat-shield. It was first mocked up out of cardboard and tape...



[...then replicated from 0.032-inch-thick aluminum sheet that RM brake-bent and welded-together. It attaches to the nearby, heat-radiating, exhaust pipe with two large worm-drive hose clamps.

Contacts

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Randy Flick From Sellersburg, Indiana Asks...

Does a Disc-Brake Caliper's Mounting Position on the Rotor Affect Braking Performance?

  Marlan Davis

Q:

I recently replaced the rotors and pads on my Pontiac G8 GT. It started me thinking about disc brake caliper placement. Most cars nowadays have wheels that are “transparent;” when in motion, you can easily see the different placement locations. I suspect the different placements are due to suspension variations and maybe even packaging considerations. Can you shed any light on this?

A:

It makes virtually no difference in braking or clamping performance if the disc brake calipers are mounted on the rotor's front (leading) side or at its rear (trailing) side. As you surmise, the location is selected primarily for suspension or body clearance, as well as aesthetics. I've even seen some old GM rear disc installations with the caliper mounting location staggered in relation to the axle and rotor (one side leading, the other trailing); this was done to clear the chassis' staggered shock mounts. On some Chryslers, in different model years and applications, the same set of front calipers may have swapped sides (driver to passenger side and vice versa), depending on the suspension and body clearance, and whether they needed to be leading or trailing to achieve the necessary clearance. That really plays hob when you're trying to get the correct replacement unit out of a wrecking yard or even an auto-parts store.

On a really high-end, lightweight car, there may be a slight advantage to mounting the front calipers in the trailing position and the rear calipers in the leading position. This moves the calipers closer to the center of the car for theoretically improved weight distribution.

Certainly the most important consideration concerning the caliper-to-rotor interface is that the caliper must be absolutely centered and square on the rotor!



[This 1955 Chevrolet fullsize passenger car is running a Wilwood Engineering front disc-brake conversion kit. The old Chevy is a “rear-steer” car; that is, the steering box is located behind the drag link and front spindles. The calipers are front-mounted for more steering-linkage clearance.]



[On some Mopars, the same right and left calipers “swapped sides” based on whether the installation used a leading or trailing caliper mounting position. On this front-mount (leading) install, the driver-side caliper is mistakenly mounted upside-down—the bleed screw (circle) faces down, when it should be at the top of the caliper, facing up. This unit belongs on the passenger side. No wonder the brakes wouldn't bleed!]

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A large advertisement for Lokar Performance Products. The top features the Lokar logo and the slogan "Evolution of Excellence!" in a stylized blue font. Below this is a photo of a silver classic car in a workshop. At the bottom, several Lokar products are displayed with labels: "67-69 Curved Camaro/Firebird Brake/Clutch Pedal Pads", "Drive-By-Wire Electronic Throttle Control Pedal Assembly", and "Groovy Edition 12 Volt Door Handles". The bottom right corner has the text "QUALITY... PLAIN & SIMPLE®" and "Photo courtesy of John Jackson of Notstockphotography.com".

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Breakin' the Law. Or the Ladder.



I'm really interested to see how the walls of traditional drag-racing formats are getting wreckin'-balled these days. The drags offer a simple concept: two cars leave the starting line and the one that gets to the finish line first wins. This has been warped quite a bit along the way. Perhaps the most well understood variation is the handicapped bracket-racing format invented by Byron Dragway's Ron Leek in the mid-1970s, and the most misunderstood are the various contortions of class indexing and handicapping within the NHRA Sportsman ranks. Outside of the big-time sanctioning bodies, common variants have included index racing (example: the racer closest to 12.00 seconds wins) and Open Comp (pro-tree bracket racing with a fixed dial-in).

Variations to the traditional competition ladder have also shown up. In the early 1970s, "Chicago-style" racing had match racers running a few rounds of competition, then the two quickest cars were the ones in the final. In 1993, Johnny Hunkins and Harry Wojciechowski created True Street for Fun Ford Weekend; cars drove 30 miles, then made three back-to-back runs and the lowest average e.t. won. That was also the format of the HOT ROD Pump Gas Drags of the early 2000s. HOT ROD Drag Week is like the ultimate extension, requiring 1,000 miles and five different race days.

[The General Maintenance is our bone-stock 2015 Charger Hellcat distressed to look like our beater General Mayhem '68. Why? Just because. It ran low-11s, not quick enough for the glut of hopped-up Hellkitties at the Red List Drags.



Thing is, all of those formats are aged enough to be called old-school. The Internet generation tends to understand elapsed time and mph, and can't be bothered with a competition ladder wherein the quicker car may not win. Either that or they want to see a mechanical bloodbath. Today's promoters are serving it up. Anything smacking of *Street Outlaws* TV is winning, such as the no-prep and parking-lot drags that have stormed the country.

Elana Scherr recently participated in the Red List Drags, wherein points are awarded for breaking performance barriers for reaction time, 60-foot, e.t., and mph. The scoring is baffling and impossible to follow from the grandstands, but the format means unlimited passes for the participants, rather than being ousted by losing a round like the old days. It rewards car performance more than human performance and has managed to draw a wild variety of cars.

For months I've planned the *Roadkill* Nationals for low-buck cars—sort of a 24 Hours of LeMons for the quarter-mile—but there's a track that beat me to it. Other outlines lurking within my computer include the Drag-a-Thon, a Pill It 'Till You Kill It event (let your imagination run wild), and a Drifty Drags.

It's all part of the new world disorder in drag racing. Adapt and survive!

►HOTROD.COM/David-Freiburger

BEHIND THE SCENES

Both **HOTROD.com** and **Roadkill.com** are changing back-end platforms soon, with some functionality updates, too.

Roadkill magazine—edited by yours truly and launched in the summer of 2015—was nominated by a professional magazine blog as one of the top 30 new titles of the year.

It's Christmas week and I'm here in the office writing copy for an April issue. Weird. No wonder the staff stopped doing Christmas-issue photos in the mag each year; they'd have to be shot in September.

Car I Most Wanted to Build on the Day I Wrote This *Roadkill* just bought a 1971 Ford F-350 crew cab, 4x4, 460-powered tow truck. I want it. I'd ditch the tow rig and make a sleeping/wrenching setup and use it as a push truck for El Mirage.

Best Instagram Pic This Month



[Remember the Crusher Camaro? It's alive and well, but its stock suspension (which has been on it even in its Faux Touring days) was a handling mess. See how it's lifting the inside tire? We solved it with QA1 suspension on an episode of *HOT ROD Garage*.

Coming Next Month: Wing Cars, Heroes Lost, and Hellcat Swaps

COMING 03.04.16

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